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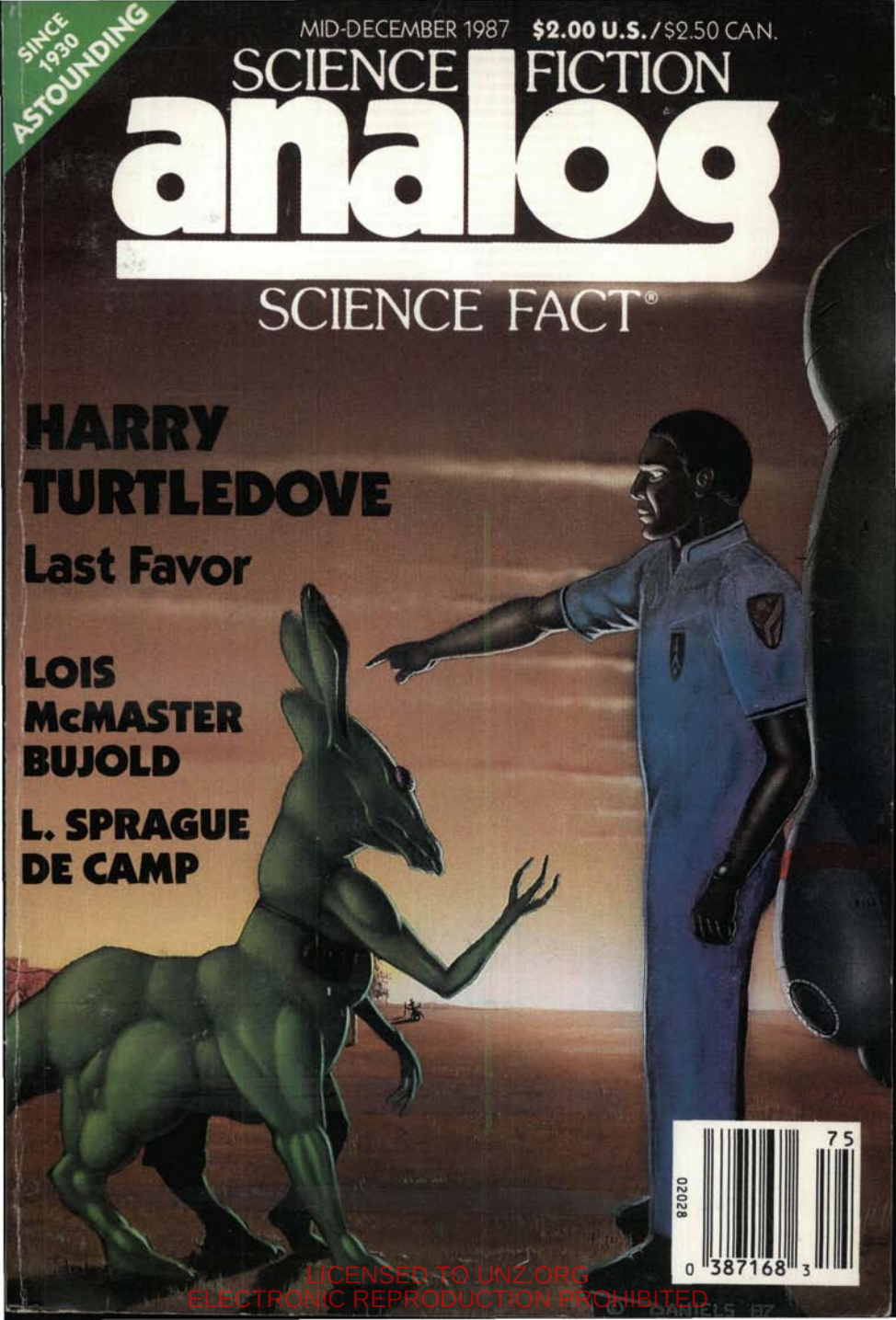

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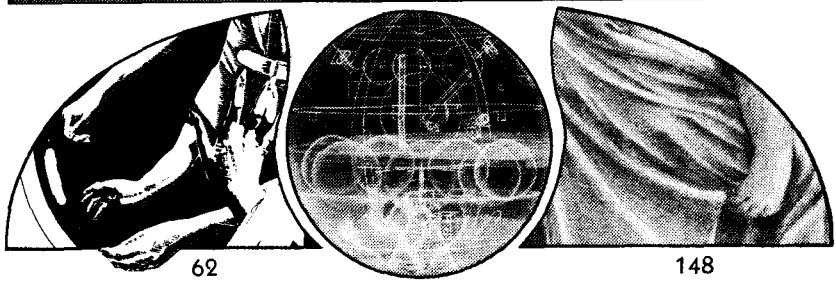

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Editorial

MATTERS OF OPINION

Stanley Schmidt

You've often heard, and quite likely even used, the expression, "That's a matter of opinion."

But how often have you thought about what it *means?*

And how about that related cliché, "You're entitled to your opinion"?

Are you? And what does *that* mean?

Consider the following group of sentences. Is each of them a statement of fact, opinion—or something else?

1. If you hold an object above the Earth's surface and let go of it, it will fall.
2. The Earth is round.
3. Organisms evolve.
4. Man evolved from other organisms.
5. God created man and everything else fully formed.
6. There is no God but Allah.
7. Killing other human beings is wrong.
8. AIDS testing should be mandatory and universal.
9. *Finian's Rainbow* was the best play of 1947.
10. Spinach tastes better than chocolate.
11. Poison ivy is a toxic plant causing itching and rash in those who touch it.

Every one of those statements is sincerely believed by at least some people. Most people who believe any one of them will tell you that it is a statement of fact.

But some of them are much more widely believed than others—and people's *reasons* for believing them vary quite a bit from statement to statement and from person to person.

Very few people would deny that #1 is a statement of objective fact—a

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real characteristic of the universe that exists regardless of what anybody thinks about it. Most nonbelievers are no longer with us, having fallen to their deaths or been crushed by falling objects. Moral: It may be admirably tolerant for people to allow each other their own opinions, but the universe doesn't work that way. On at least some matters, the universe recognizes only one opinion as correct, and ruthlessly punishes all dissenters.

Most people today would also agree that #2 is a statement of fact, though a wee bit oversimplified (rounded off, so to speak). Of course the Earth is a trifle oblate and lumpy, but a wide range of evidence, from circumnavigation to direct observation from orbit, shows that the planet is, to a very good approximation, spherical. But a Flat Earth Society still exists, and its members still profess (and presumably hold) the belief that the Earth is flat. Is that a matter of opinion? Is the "real" answer different for Flat-Earthers and for the rest of us?

Most of us can probably agree on an answer to that last question: the answer is *not* different for different people. The real Earth has one shape; people disagree about what it is because they do not all have (or accept) the same evidence from which to determine it. The true shape of Earth is an objective fact; people's opinions about it are beliefs *about* that fact, based on more or less incomplete and imperfect evidence. Are all opinions equally valid? No: the universe has a strong prejudice in favor of those that most closely resemble facts. Lacking the universe's position of authority, how can we choose among opinions? Many methods are in use, but the universe seems to favor those which work by evaluating evidence. Sample statement #1 is the most generally believed on the list because everyone has a lifetime of personally collected experimental data to support it. "The Earth is round" is less widely believed because more of the evidence is indirect and/or second-hand, requiring trust in other observers. But there is some justification for that trust, and the hypothesis fits the data. "The Earth is flat" is much less widely believed because it *doesn't* fit the facts (unless you choose to arbitrarily ignore those facts that you find inconvenient). In a word, it's a *wrong* opinion about the fact of the Earth's shape.

Statement #3 is hard to deny if you pay the slightest attention to what actually happens on a farm or in a biology lab, but #4 and #5 remain hotly contested because hardly a man is now alive who was around to watch. Therefore an opinion about the fact must be determined on some basis other than direct, firsthand observation. People who understand and appreciate the power of evidence and logical inference tend to favor #4; people who disdain or don't understand evidence and logic are likely to go for some form of #5, justifying it by an appeal to some Authority. But there is a wide selection of Authorities to choose from: a great deal of blood has been shed over people's belief or disbelief in statements like #6.

All the statements so far have been widely held opinions about objective

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facts presumed to exist, whether or not they are available for full and direct examination. Number 7 and number 8 get a little trickier: exactly what do words like "wrong" and "should" *mean?* Both statements are strongly believed by some people, and strongly disputed, or at least qualified, by others. They don't lend themselves to simple factual analysis—but if they are "just matters of opinion," and all opinions are considered equally valid, then there is no basis for any sort of moral code.

And therefore no basis for civilization.

Statements #9 and #10 are of a type commonly referred to as "opinion"—but they aren't, at least in the sense I've been using (and will soon define) that word. They are statements of *taste*; and

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tastes, by their very nature, are not subject to dispute (even though people have wasted vast amounts of time and energy disputing them). If I believe that *Finian's Rainbow* was the best play of 1947, that's an accurate, incontestable statement of how it reacted with my dramatic and musical preferences —nothing more and nothing less. Your "opinion" is utterly irrelevant to that factual statement of relationship, just as mine is to the corresponding statement of *your* reactions. If you found it the worst play of all time, then it was—for you. There is no contradiction between your "worst" and my "best," because we're talking about two different things. We are *not* talking about an intrinsic property of the play (even though the language may fool us into believing we are), but about two independent *relationships* between it and two individual observers. If the play in question won a "Best of 1947" award, that represents nothing more or less than a statistical summary of such relationships for a finite number of individuals. It does nothing to redeem the play for someone who hated it; nor does it mean that his taste is "bad." (In this connection, you might be interested in "Broccoli, Oranges, and Science Fiction," my guest "Viewpoint" column in the May-June 1985 issue of *The Twilight Zone*.) Similarly, whether spinach or chocolate tastes better is a question that can only be answered by and for an individual. Each person's answer is factual, but applies only to him; he cannot expect to find universal, objective Truth by comparing notes.

Finally, statement #11: At first glance, this might appear to be in the "objective fact" category, but it actually has more in common with #9 and #10. It's easy to verify experimentally that poison ivy has exactly the effect claimed—on some people. But others can walk right through the stuff with no effect at all. Toxicity, like taste, describes not an object, but an *interaction* between an object and a person—and it can be different for different individuals.

So—it seems that things commonly thought of as knowledge and/or belief actually subdivide more or less naturally into at least three categories: fact, opinion, and taste. I propose the following working definitions:

A *fact* is something which is objectively true, regardless of who looks at it or what he thinks about it. Highly probable example: "The Earth is approximately spherical."

An *opinion* is a belief about a fact—that is, an attempt to state a fact—based on incomplete or uncertain knowledge. Example: "Eliminating prayer from schools is causing the breakdown of society." (Either it *is* doing that, or it's having some tendency to, or it's having no such effect at all; the speaker isn't sure, but is willing to make a guess based on what he thinks he knows.)

A *taste* is a fact about a specific person's relationship with an external object. (Please note that this is a little broader than the usual usage.) Obvious example: "Chocolate tastes good (or bad)." Less obvious example: "Poison

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ivy gives me (does not give me) a rash."

There are things which are truly matters of fact, and others which are matters of taste. I have been unable to find an example of a genuine "matter of opinion," unless by that you mean a matter of fact about which nobody knows enough to speak confidently and convincingly.

However, I have observed many times that a great deal of human confusion, pain, and misguided action results from failure to distinguish among the three categories, or to recognize which one a particular belief belongs to. Taste is routinely confused with opinion; both are mistaken for objective fact.

The holder of any belief is likely to regard it as a clear, undeniable fact, without examining the basis of his belief. Or he may shrug off a serious attempt to resolve a dispute by saying, "It's a matter of opinion."

I had a lot of occasion to think about these matters when reading the many letters provoked by my June editorial, "Child Abuse," which commented on a recent court decision on school books in Tennessee and suggested that education exposing children to a very limited range of ideas did them no favors. Two of these letters in particular seem to warrant comment here.

One pointed out that many of the Tennessee book-banners sincerely believe they are fighting the Devil, and that this is difficult even for adults and even more so for children. My view of censored education as intellectual child abuse is "not self-evident to folk who insist on the primacy of faith over reason." This is almost certainly true: these parents hold an opinion in light of which my points are incomprehensible, and any long-range solution will have to deal with that fact.

The other letter points out that all parents in all cultures make choices for their children—which is also true, but ignores the distinction I tried to make: that *some* parents' choices are directed toward enabling their children to make intelligent choices for *themselves* by the time they grow up, and that that approach better prepares them to live in whatever world they must live in. "It isn't really child abuse," this letter claims, "when Fundamentalists choose values you don't like in education. Possibly they regard our parenting as child abuse."

No doubt they do—but does the fact that they hold a particular opinion mean it should automatically be treated as fact? If the mere holding of an opinion is going to be considered sufficient justification for actions profoundly affecting other people, then few holds are barred. What if some parents believe their children should be taught to live by robbery and extortion, with lots of instruction in technique and none in moral arguments against that kind of a lifestyle? Should we tell them, "Sure, do it your way; your opinion's as good as mine!"?

All opinions are *not* equally valid, and decisions imposed on other people need to be based on the *best* opinions possible. An opinion which approximates objective fact quite closely is better—as judged by the realities of the

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universe—than one which only dimly resembles fact. Often the only available basis for judging how closely opinions resemble facts is an evaluation of the evidence and reasoning on which they are based. Opinions based on strong evidence personally collected inspire the most confidence, but no one has time to decide everything that way. Science, at its best, provides the next best thing: a consensus of evidence collected by many observers trained to avoid pitfalls, and reproducible by anyone who cares to take the trouble. Religious dogma relies primarily on acceptance of authority. Objective, reproducible evidence plays at best a minor role, and is often explicitly downplayed or rejected; only a few select people are allowed to evaluate or question. In practice, there are similarities between science and religion that practitioners of both need to be aware of: both depend on evidence not collected personally; both are largely in the hands of specially trained people; and even science sometimes degenerates into authoritarianism. But one, when done right, involves the ongoing collection of evidence according to rigorous rules and subject to independent confirmation by anyone, while the other rests on official pronouncements open to little or no change or questioning. It would be presumptuous for one human being to tell another he *can't* believe anything he wants on that basis—but it's no less presumptuous for one to tell another he *must* believe something without a reason they can both see and agree on.

Observation and logic are the only tools we have with enough objectivity to do that. In matters of morals, ethics, and public policy, it makes sense to prefer some opinions over others on the basis of what objective *effects* they can be expected to have—based not on emotional guesses or what someone else says, but on the solidest evidence and logic available. In education, for example, will children and the society they will eventually inherit be better served by letting them see only a very few prescreened ideas—or by letting them see a wide range (*including* those of the Fundamentalists) and teaching them to judge relative merits in an intelligent way?

Including, very prominently, teaching them to distinguish among fact, opinion, and taste—and to judge where in the spectrum a given belief lies. ■

● Who so belongs only to his own age, and reverences only its gilt Popinjays or soot-smeared Mumbojumbos, must needs die with it.

Thomas Carlyle

(Submitted by G. Harry Stine)

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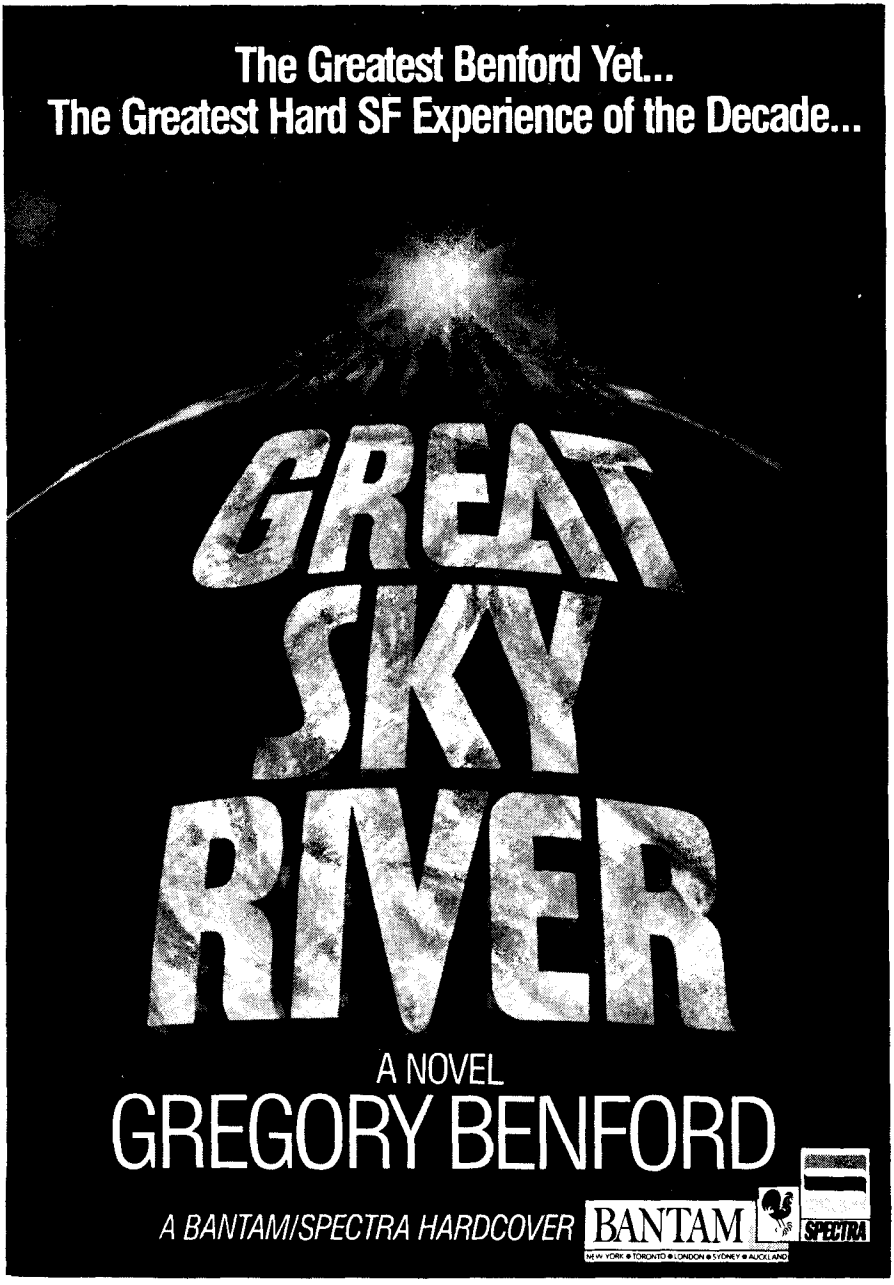

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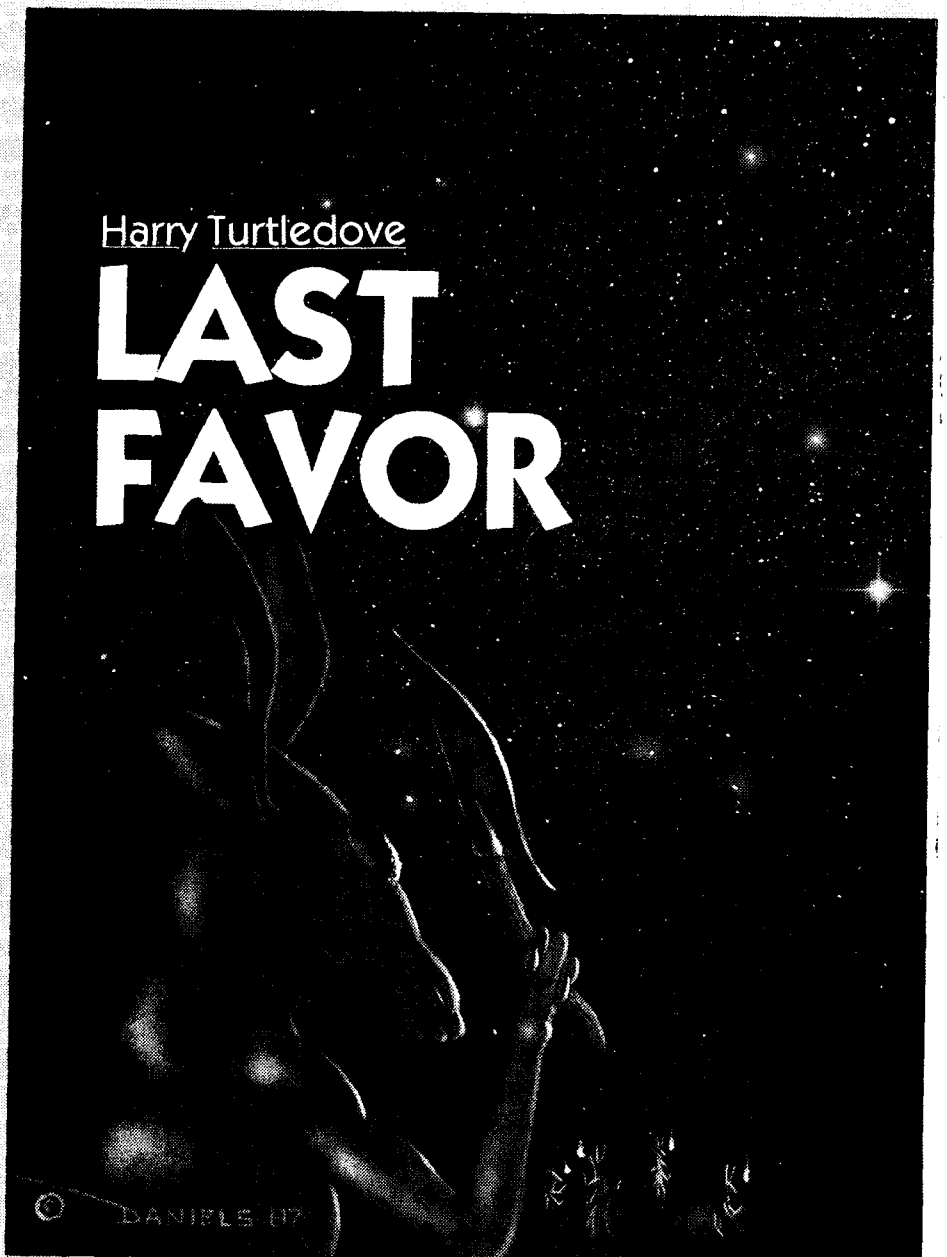

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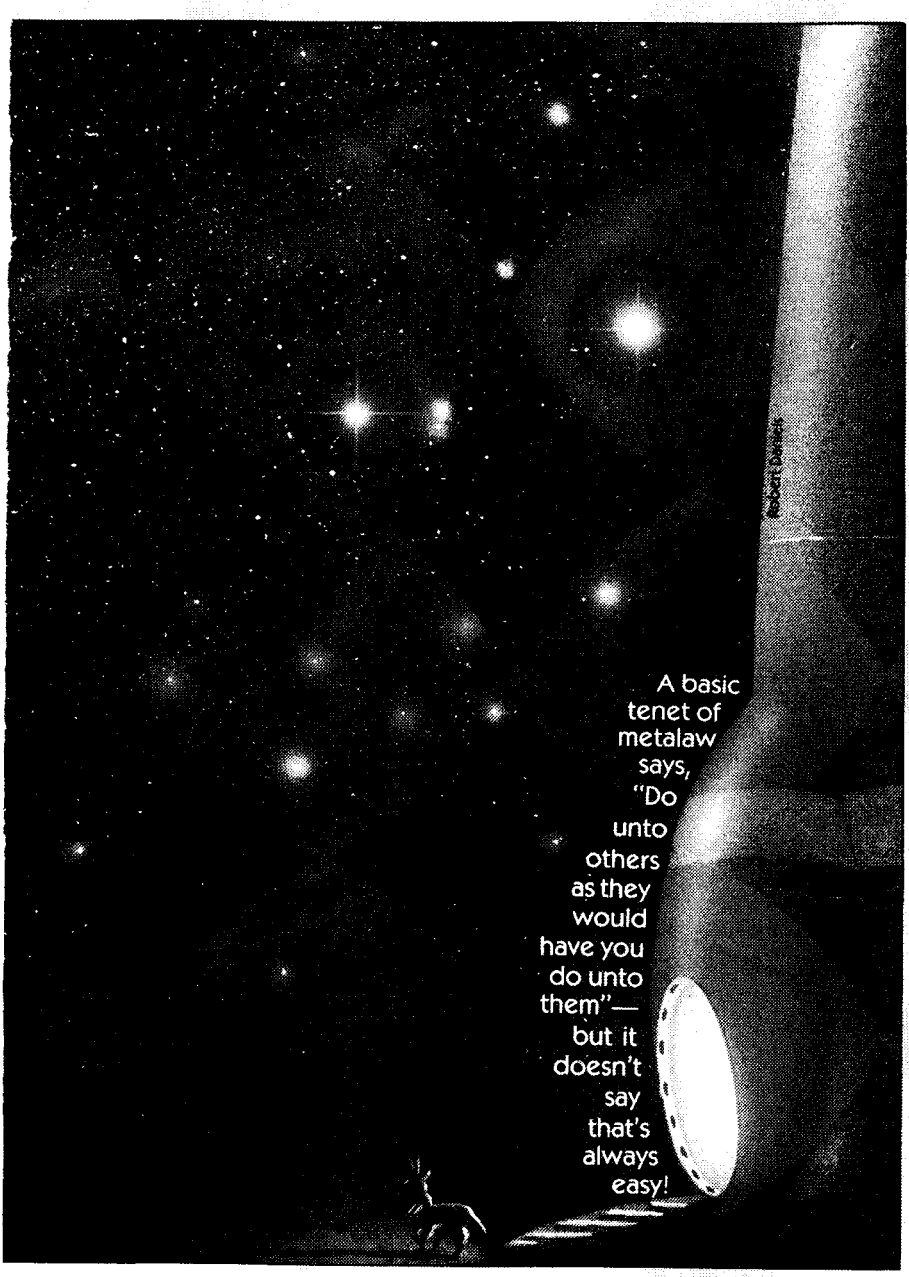

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Jerome Carver glanced at the *Enrico Dandolo*'s west-facing view panel. It seemed awash with flame. "Spectacular sunset," the big black man remarked.

"What else is new?" Patrice Boileau was the only other person in the trade-ship's control room. She did not bother looking up from the screen where she was checking a computer subroutine.

"You're spoiled," Carver said in mild reproof.

Patrice shrugged. "There'll be another one along tomorrow. Maybe I won't be busy then."

She was likely right, Carver thought. With an oranger sun and thicker air than Earth's, the whole world of Ephar ran to glorious nightfalls and early mornings. The towers and spires of the city of Shkenaz, silhouetted blackly against the glowing sky, added a touch almost of Arabian Nights fantasy to the scene.

As the trader watched, Ephar's sun slid below the horizon. Full darkness, though, was still some time away. Carver had no trouble spying the figure dashing from Shkenaz's walls toward the greenskin town outside, or the mob at the fugitive's heels. He groaned. "Oh, God, they've caught a late one."

This time Patrice did join him in front of the view panel. Of themselves, her hands knotted into fists. "Maybe he'll make it," she said. "If he gets back to his own kind before they catch him, they'll let him go—it's not the gods' will that he die this time."

"If," Carver said grimly. Greenskin towns, by law, had to be more than three *gibyat*s from the walls of a city. Say, a kilometer and a half, the trader thought. He wondered what misfortune had stranded the luckless runner inside Shkenaz so late. He must have known the risk he was taking.

Patrice stepped up the gain on the panel. The distance between the fleeing green centauroid and his blue-skinned pursuers seemed to swell, but that was only electronic illusion. "Run, damn you, run," Carver muttered.

It was no good. A thrown stone made the greenskin stagger. That was all the fastest members of the mob needed to catch him and drag him down. Bodies thrashed, one of them not for long. After a while, realizing there was no sport left to be had, the troop began walking back to Shkenaz. Every so often a blue would spring into the air, in sheer high spirits.

Carver swung the west-facing camera to look at the greenskin village. Sure enough, two or three males stood near the boundary-stone. They must have seen everything. They made no move to retrieve what little was left of their fellow, though. They would not, till morning. If a blue patrol caught them coming out at night, the whole village might die to expiate their sin.

With a wordless sound, half fury and half frustration, Carver stabbed a finger at a button under the view panel. The panel went dark. "Three thousand years," the trader said.

Patrice had never been on Ephar before. "Three thousand years of what?"

"That." Carver waved to the blank view panel. "Maybe even longer, but 3,000 years the locals have records for. The separate villages, the night ban . . . the murders." In the six months since the *Enrico Dandolo* landed, he had seen three now. That accorded fairly well with the data other ships visiting the Araite Empire had gathered.

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"I don't—want to believe that," Patrice said.

"Believe it," he told her. "The best part is, under the Code we can't do a damn thing about it, either."

Now she stared at him. "What? Why not?"

"No complainants." Traders rarely meddled in the affairs of worlds without spaceflight. When they did, they needed ironclad documentation that a local group not only seemed oppressed, but felt itself to be. Judging from a purely offplanet perspective was, sensibly in most cases, against the rules.

"I don't believe it!" Patrice exclaimed.

Carver shook his head helplessly. "Believe it. It's true. Never one, in the two hundred years since tradeships have been coming here. Not the blues, of course—why should they complain? But not the greenskins either. They just shrug and say they are all guilty by inheritance and deserve whatever the blues hand out to them. They believe it. As long as they believe it, officially there's nothing we can do."

"Officially," Patrice said. There was precedent for bending the Code when it needed bending. On Ephar, it looked to need more than bending.

"I understand you." Carver ran a hand down his dark forearm, reminding her of his race. "Don't you think I, of all people, want to see the greenskins free? The night ban is just the worst of a whole set of restrictive laws. Greenskins can't hold land, they can't intermarry with blues, they can't—oh, a raft of things. Basically, they live by their wits, because that's all they're allowed to own. And—" He slammed the flat of his hand down on the console in complete frustration. "—they won't do a damned thing about it."

"You've tried?"

"My last trip in. I'm not the only one, either. It's never done a bean's worth of good. They won't take weapons, they won't learn civil disobedience, they aren't interested in our trying to change attitudes among the blues. They're—content. And it drives me crazy."

"I don't blame you a bit," Patrice said. "What are you going to do now?"

"Keep trying. What else?"

Carver tramped toward Shkenaz. A few puffy clouds floated in the green-blue sky. The breeze was at the trader's back, and full of strange sweetnesses. Had it been blowing the other way, it would have brought him the stink of the city.

Only a long trampled swathe of foliage, abruptly ending, showed what had happened the evening before. As soon as the sun was up, the greenskins had taken away their dead fellow.

Carver felt his eyes keep sliding back to the mute evidence of violence. Walking along beside him, Lloyd Michaels noticed (Carver's fellow trader did not miss much). "Nothing we can do about it," he said.

"I know," Carver ground out. He stopped to adjust his pack; the straps were digging into his shoulder. "Heaven knows we've tried. It galls me, though, to watch a lynching and then deal the next day with the lord who condoned it."

"I dare say we do that on a lot of primitive worlds, and on a good many

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that aren't." Michaels's face looked too round and pink and innocent for him to be as cynical as Carver knew he was, a fact he used to shameless advantage on every planet where the locals were sophisticated enough to try to read human expressions.

"They don't usually get their victims to agree they should have been lynched," the black man retorted.

"There is that," Michaels agreed mildly. "If we knew how they did it, we could make a fortune selling the secret offworld."

Carver glared at him, a little less than half sure he was joking. "I'm going to talk to Nadab today," he said at last.

"Old Baasa's pet greenskin? Sure, go ahead. I expect he'll be there." Michaels cocked an eyebrow at his companion. "It won't do you one damn bit of good."

"I'll do it anyhow," Carver said. He walked on, looking neither to the left nor to the right, plainly ready to ignore anything more Lloyd Michaels might say. Michaels kept his mouth shut, the most annoying thing he could do.

The walls of Shkenaz drew near. The gates were open. The guards (blues, of course) leaned back, their weight supported by hind legs and stiff, thick tails. They were bored, Carver thought.

Some—not all—of that boredom fell away as the traders drew near. Even though humans had been going in and out of Shkenaz since the *Enrico Dandolo* landed, they were still strange enough to be interesting. The guards came forward and down onto all four running legs, held spears across the entranceway to block the traders' path. "With whom have you business in the city?" one of them demanded sternly.

Carver studied the male as if seeing him for the first time. Centauroid was only a vague description of the locals' body plan; the guard's hindquarters were not much like a horse's, and his upthrust torso even less like a man's. His face was most alien of all, with a wide toothless beak of a mouth, twin nostril slits, and insectile compound eyes.

The trader wondered how strange he looked in those eyes.

Michaels said, "We meet today with the mighty lord Baasa, representative in Shkenaz of the Araite Emperor, may his reign be long and prosperous." The guttural local language was made for sounding arrogant.

The guard swung up his spear. "Pass, then, into Shkenaz, and may our governor's graciousness shine upon you."

Change the style of architecture and the shape of the inhabitants, Carver thought, and Shkenaz was much like any other primitive town on a preindustrial world. Intelligent beings needed places to live, to trade, to worship; and arranged those places in fairly standard patterns.

Differences, though, counted too. Because of the way the locals were made, Shkenaz seemed spacious to a biped like Carver, although the townsfolk likely would have disagreed. Few animals shared the streets with the natives, who were strong enough to do their own hauling.

On a street corner, a greenskin scribe wrote a letter for a blue; another blue waited his turn. Carver pointed. "They're polite enough now, but I wonder how

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many wolfpacks they've run in after dark."

"As many as they could, I have no doubt," Michaels said.

By now, most of the locals were used to seeing humans in town, and gave them no more than casual glances. The trumpet-shaped ears of a farmer in town with a piece of scrap iron on his back, though, rose in surprise and his head whipped round to follow the traders as they walked toward the main market square. The junkshop owner with whom he was dickering, a greenskin, took advantage of his surprise to close the deal on the spot.

Carver, who was in earshot when he did, felt like cheering. "We got that fellow some extra silver there," he said.

"So we did," Michaels agreed. "We also may have got him in trouble some time down the line, for cheating a poor honest yokel who had come into Shkenaz to cheat him. When you're a blue here, you can afford a long, selective memory for such slights."

Black skin, as Carver had discovered, had its uses. He felt his cheeks go hot, but his companion could not see him flush.

Shkenaz's central agora had the air of barely controlled chaos usual to marketplaces. Sellers loudly sang the virtues of six-legged meat animals, knives, perfumes, fruits, grains, pots of clay and brass. Would-be buyers just as loudly named them liars and thieves. Business got done all the same.

A bookseller waved a three-fingered hand to draw the humans' attention. When he had it, he held up a leather-bound codex. "Illuminated by that painter from the eastern provinces whose work you like," he called cajolingly.

"Do you want to stop?" Carver asked.

"Not with Baasa expecting us. Keep the powers that be happy first." Michaels turned to the waiting greenskin. "Another time, Harhas. We go now to an audience with the august governor of your great city."

Harhas dipped his head. "May it be prosperous for you."

Temples and Shkenaz's town hall fronted one side of the agora. Before the town hall, as before public buildings in every town of the Araite Empire, stood a statue of Peleg. Peleg was the ancient king of a city-state somehow (Carver was not sure how; no human was) connected with the rise of the Empire. More than 3,000 years ago, a greenskin had assassinated him. Greenskins had been paying for it ever since.

A servant was waiting outside the hall. "I am to take you to his excellency."

The humans followed him up the ramp. A mosaic that ran the whole length of the wall showed in gruesome, imaginative detail what had happened to Peleg's murderer. Golden tesserae gave the work its title: "Justice."

An artisan was replacing a few tiles that had fallen out of a particularly lurid scene. The artisan was a greenskin. "Nice to be reminded of where you stand in the public's esteem, isn't it?" Michaels murmured. Carver grunted, too mortified for the greenskin's sake to say a word. Baasa's servant glanced back at them. They did not translate for him.

Locals, most of them blues, bustled

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by, too intent on their own affairs even to notice the craftsman at work. To Carver, somehow, that was the worst part of the whole business.

The servant ducked into a chamber, emerged a moment later. "His Excellency will see you now."

"Good day, good day," Baasa rumbled from behind his desk as the humans came in. An icon of the reigning Emperor hung on the wall behind him, a reminder of the power that sprawled halfway across this continent. Baasa needed no more than such a symbolic reminder to administer Shkenaz. He was shrewd and fairly able . . . and if that did not suffice, Carver thought, he had Nadab.

The greenskin stood at a table to one side of his master's desk. Like most of his kind, he had eyes a little larger than those of blues, and ears of not quite the same shape. Still, even taking skin color into account, the visible differences between Nadab and Baasa were less than those between Michaels and Carver.

"Shall we begin?" Carver said.

"Yes, let us," Baasa answered. Nadab merely dipped his head a couple of centimeters, to show he was ready.

The humans unslung their packs. As with long-distance caravans on ancient Earth, trade goods worth hauling across light-years had to combine low bulk and high value. Michaels went first. He was a jeweler, and offplanet baubles had grown popular on Ephar over the years. Pearls sold especially well, as they had no local equivalent.

While Michaels and Baasa haggled, Carver made small talk with the governor's aide. At last, seeing Baasa deeply involved in a hot dicker, Carver dared say, "I am sorry one of your people perished last night, Nadab."

"It has happened before," the greenskin said with a fatalism that never failed to chill Carver. "It will happen again. In the end, we are the better for it."

As near as the trader could remember, Nadab had used exactly those words the last time a greenskin died from missing the sunset curfew. Now, though, he seemed on the point of going on when Baasa interrupted to ask, "How much of the *kohath* spice did we set as value for a shimmerstone"—the name the locals gave to pearls—"of this size?"

"Sir, let me see it." Nadab walked over the Michaels, who held out the gem. The greenskin examined it. "Seven measures," he said at once (literally, it came out "one-one"; the locals used six as their counting-base).

"Oh, you thief!" Baasa and Michaels said together. They pointed fingers at each other and laughed. One had been claiming five, the other ten. Neither, though, cared to argue with Nadab.

The greenskin returned to his place. When Carver tried to pick up the conversation where the two of them had left off, he deftly changed the subject. A few minutes later, another disputed point cropped up. Nadab settled it with the same quiet competence he had shown before.

At last Michaels said, "That's about it for me, Your Excellency. Why not let Jerome take his turn?"

"Very well." Baasa swung his unwinking gaze on Carver. "What have you to offer me today?"

"Knowledge itself," Carver replied in what he hoped was an impressive

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voice. "What could be more valuable to you and to the Empire than knowledge? It is by knowing many things, after all, that we humans learned the art of flying from star to star."

Baasa's ears quivered and came to attention. "You would sell the secret of your flying ship?" he demanded. Reading tone into an alien's words was always risky, but Carver thought he heard disbelief warring with greed.

Before he could say anything, Nadab broke in: "My lord, if he makes that claim, he seeks only to befool you. We lack too many of the mechanic arts known to his people to hope to duplicate what they can do."

The Araite Empire's technology was about on a par with that of Rome in Earthly history. Like the Romans also, the locals were more sophisticated intellectually than they were with their hands. Knowing there were things one could not do was a realization many societies never reached.

Carver dipped his head to Nadab, turned back to Baasa. "Your esteemed counselor is right, of course, your excellency—"

The governor gestured impatiently. "I pay the greenskin to be right. What good is he to me if he is wrong? So you cannot tell me how to fly, eh? What knowledge do you sell, then?"

"Knowledge that will put you on the road to learning such things for yourself, and that will show you the direction that road takes."

"Riddles," Baasa muttered. Local "science," again like Rome's, was of two sorts: collections of random facts with little theory unifying them (what passed for chemistry was like that) and, more common, huge forests of speculation springing from an acorn's worth of knowledge. Medicine and physics were both tarred with that brush.

"Not so," Carver said. "Here, for instance." He drew from his pack translations of Galileo, Bacon's *Novum Organum*, and his prize, an edition of the *Origin of Species* with its concepts intact but examples drawn from Ephar's biology. None of the three were so far beyond local thought as to be incomprehensible; taken together, they ought to stir things up a good deal.

That was what Carver had in mind. The best way to help the greenskins, he had decided, was to change the society of which they were a part. It was slower than more open forms of aid, but in the long run much more certain.

Baasa was working through the summaries printed on the flyleaves of the books. "See what you think, Nadab," he said, passing them on to his aide. He turned back to Carver. "Give me a price. The ideas may be interesting, though the style is rather flat."

Carver winced. He hoped that was a ploy to knock down the price, but suspected it was not. Some good linguists and computer people had put his translations together, but it took more than competence to be elegant in a language not one's own. It took inspired genius, and Joseph Conrads did not come along every day, or every century either.

Nadab read faster than Baasa. He set the books on the table in front of him. "Quite abstract," he said. "Still, if they are affordable, perhaps you might seek to acquire them as curiosities."

"Yes, perhaps so," the governor agreed. "Curiosities they certainly are.

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Well, trader, what do you say to five measures of *bulun* powder apiece for them?''

''Your excellency, who is esteemed throughout the Empire for his generosity, is pleased to joke with me.'' Carver was appalled, for a couple of reasons. The first was the paltry offer. The translations had not come cheap; fifteen measures of *bulun* powder would not begin to pay off what they had cost him.

Even Lloyd Michaels, who had kept out of his fellow trader's dicker till then, was moved to protest, ''Surely savants throughout the Empire should have the chance to learn of these ideas for themselves.''

''And you, your excellency,'' Carver said to Baasa, ''and your assistant deserve the credit you will gain for being the first to pass this new knowledge on to your people.''

Baasa swung his head Nadab's way. Nadab said quickly, ''I deserve no credit. I am but a greenskin. All that I have, I owe to my lord the governor. Without him, I am as nothing, nor do I seek any acclaim for aiding him in any way I can.''

The hell of it was, Carver thought, that he sounded as though he meant it. He would have been much easier to deal with, were he only mouthing polite phrases.

Nadab's self-effacement out of the way, Baasa proved a little more interested in dealing. He upped his offer to eight measures of *bulun* powder a book, then to ten, which was about half what Carver needed to break even. When at last he got up above ten measures, the haggling turned serious.

Baasa said, ''Twelve measures then, and four parts, and three parts of parts.''

''Twelve and three-quarters, by your reckoning,'' Nadab said to Carver, while the trader was still wrestling with the fraction that needed converting. He ruefully shook his head and stuck his calculator in his hip pocket. If Nadab felt like showing off, that was fine with Carver.

In the middle of the dicker, a servant poked his head into the chamber and said to Baasa, ''Your pardon, Excellency, but the delegation from Asnah has arrived.''

''Oh, a pestilence! I did not expect them until tomorrow. I suppose I must formally greet them, as protocol requires.'' The governor started to walk out, then turned back to warn Carver, ''Think not that I shall forget where we stand: seventeen and three parts per volume, and I doubt you will squeeze another measure from me.''

''And a half, that is,'' Nadab supplied as Baasa hurried away.

''Yes, of course,'' Carver said abstractedly. He had Baasa gauged now, and did not think he would end up losing money. Nadab, though, was harder to figure. ''May I ask a question without fear of giving offense?'' he said to the greenskin.

''How can seeking to learn give offense?''

Carver could have named twenty different ways from twenty different worlds, but forbore. He said only, ''I hoped you might see the advantage to your people of helping to spread enlightenment in the Empire. That you do not, surprises and disappoints me. If you have some

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reason I cannot see, I would be grateful for your telling me what it is."

The greenskin was some time silent; the trader could make nothing of the steady gaze that met his. At last Nadab said, "You tread on overgrown ground, outlander. Be careful lest you stumble."

Carver waited.

Something like a sigh hissed through Nadab's nostril slits. He picked up the adaptation of the *Origin of Species,* turned it over and over in his hands. Again, he was a long time finding words. When he did speak, he sounded as though he was choosing them carefully: "I did not know, outlander, that this notion of change over time was familiar to your people."

Carver's eyes slid to Michaels. His comrade was staring back at him. Of all the things he had thought he might hear, this was the last. He said, "I did not know the folk of the Empire had come across it, either."

He started to go on, then stopped. Anything he said might be wrong. But no one in the couple of centuries of fitful contact between Ephar and the universe outside had had any clue that the locals were within light-years of developing the concept of evolution.

"Ah, yes, the folk," Nadab murmured. Carver thought he heard irony in the local's voice, and warned himself not to let his sympathies—or his imagination—run away with him. Then, abruptly, he was sure he had not. In the language of the Empire, "folk" and "blue" sprang from the same root.

Excitement flowered in him. He had brushed against something more important than *bulun* powder here; he was sure of it. "Tell me," he said, "have you greenskins writings of your own? Ones the folk of the Empire"—he used the term with deliberate emphasis—"know nothing about?"

If Nadab said yes to that . . . But he did not. He only asked, "Outlander, how could it possibly matter to you?"

"If for no other reason, then as trade items," Carver said.

Before the words were out of his mouth, he knew he had made a mistake. Nadab's eyes might be unreadable, but there was no mistaking the finality with which he said, "I see little point to discussing what are, in any event, shadows."

The trader cast about for a way to put things right. Nadab stonily rebuffed his efforts. Baasa came back, which assured the subject would stay closed. Distracted, Carver ended the dicker too soon. The city governor fairly glowed with self-satisfaction; he did not often get the better of a bargain with humans.

"If I may suggest something, Excellency—" Nadab said.

"Yes? Go on. Say what you mean." Baasa was in a magnanimous mood.

"You have been gracious enough to speak kindly of my prose style, inadequate though it is. Perhaps, before you release these works to learned males all over the Empire, I might do my poor best to make them conform to the rhetorical standards such publication requires."

"A capital suggestion," Baasa exclaimed. "See you to it, Nadab. Only make sure you proceed with it. I would not want the works long delayed."

"Certainly not, excellency."

It was all perfectly smooth, perfectly respectful, and, from the locals' point

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of view, perfectly sensible. Somehow, though, Carver was sure that whatever sprang from Nadab's pen would be flawed: not obviously flawed, maybe, or no one would look at the books at all, but with enough errors to keep them from having the influence for which he'd hoped.

He could not say that out loud, not with no proof, not with the greenskin enjoying his overlord's deserved confidence. But for whatever reasons, Nadab was plainly unenthusiastic about letting real science come to the attention of the Empire as a whole. If Carver had been frustrated before about the way greenskins acted, now he was bewildered as well, and more than a little annoyed.

He did what he could, saying, "If you have any trouble with the concepts in the books, Nadab, please feel free to call on us humans for help."

"That is generous of you," the greenskin said. "If I encounter difficulties, be sure I shall consult you. I believe, however, that my grasp of what is, after all, my own language should prove adequate to the task."

"What task do you have in mind?" Carver said, but in Trade English, so that only Michaels understood.

"Well, of course we haven't had a great deal to do with the greenskins," Captain Chen remarked that evening over tea and cakes. She was a tiny, very competent woman whose size belied her strength of will. She went on, "They aren't rich enough to trade with the likes of us."

"Some of them must be," Michaels said. "Nadab has been Baasa's right-hand man for years. Are you telling me he hasn't spent some time lining the pockets he doesn't wear?"

"I would doubt that myself," the captain said dryly.

"So would I," Carver agreed. "But even if he has, he doesn't dare show it. What do you suppose happens if somebody in a greenskin village starts looking too prosperous?"

"The blues come out and burn his house down around his ears," Michaels supplied, "and probably his neighbors' houses too, just on the off chance that they're thinking wicked thoughts about living above subsistence level."

"You've got it," Carver said. "We have tapes to prove it. It doesn't happen very often, though. The greenskins have *been pariahs for a long time now; they* know how to lie low."

" 'Pariah' isn't quite the right word," Captain Chen said, precise as usual. "The greenskins play an important part in local society: shopkeepers, scholars, artisans, merchants. They aren't menials, by any means."

"So long as the sun is in the sky," Carver said. "They aren't menials after dark, either—they're fair game. Still, I take your point. It's just because of the role they play that I wondered if they have a literature of their own."

"From the way Nadab clammed up about it, you'd have thought Jerome asked him how many blue children he'd eaten lately," Michaels added.

The captain pursed her lips. "Interesting," she said judiciously, "but I'm not sure how important it is."

"*Something* odd is going on there," Carver insisted. "Nadab knows about evolution, and none of the natural phi-

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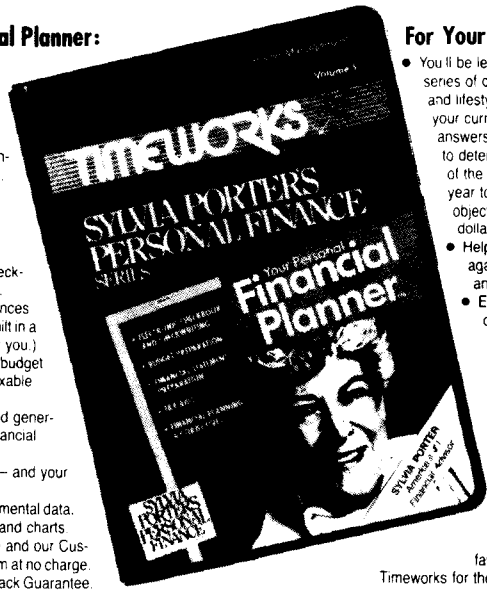

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losophers among the blues do. I'd lay money on that."

"The other thing," Michaels said, "is that he didn't want them knowing about it, either."

Carver gave him a grateful look. "So you saw that too?"

"Interesting," Captain Chen said again. "The more enlightened, the more scientifically oriented a society is, the less inclination it usually has for harassing its minorities, at least openly. You'd think Nadab would grasp that."

"I think perhaps he does," Carver said slowly.

Michaels parted company with him there. "That's crazy, Jerome. Nobody wants to be persecuted forever."

"Till my first trip to Ephar, I would have said the same thing." Carver scratched his head. "But if the greenskins don't, they certainly hide it well. And I don't just mean Nadab. None of them seems interested in changing the way things are."

"They *are* a small minority," the captain said, "and very vulnerable because of that. They must know it."

"That's true enough," Carver admitted. "I've never seen a greenskin I'd call a fool."

"Hardly," Michaels agreed. "A greenskin who was a fool wouldn't live long."

"But still—" Carver said.

"Yes, but still," Captain Chen said. "Yes, it is a puzzle. If it can be arranged so as not to disturb the imperial authorities in Shkenaz, you might pay a visit to the greenskin village."

"There's no profit in it," Michaels said.

"Money and profit are not always the same thing," the captain said.

The locals' faces did not show many emotions a human could read, but the set of the blue guards' ears and the way they only stood aside at the last moment for Carver to pass told the trader plenty about what they thought of his having anything to do with greenskins.

Nadab came out past the village boundary stone to meet Carver. It was safe enough; local noon had only just passed. The greenskin waved a hand. "Welcome, outlander. Shall we stroll?"

"Whatever you wish, of course," the trader said, falling in beside Nadab. After a little while, he asked casually, "How are you coming with your, ah, editing of the volumes Baasa acquired?"

Nadab did not miss a beat. "Well enough." Carver shook his head in rueful admiration: the greenskin was as polite as he was uninformative.

They went into the village. Carver had walked past it many times, and seen it from the *Enrico Dandolo*'s view panels, but he had hoped actually being in it would give him some new perspective on the way greenskins lived their lives. He found himself disappointed. The houses were as he'd already known they were: old, not especially prosperous, but on the clean side by local standards.

Some elderly males stood in the village square. They crowded round to get a good look at Carver. Females and children peered from doorways. Most of the adult males in their prime were working in Shkenaz.

Also in the square was something

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Carver did not remember noticing: a statue of Peleg. Maybe, he thought, he had not wanted to see it before. He pointed at it. "Why do you have this here?"

"To remind us of our shame." It was a chorus, from all the greenskins in earshot, even the youngsters. Carver realized he must have asked a ritual question. The humiliation drilled into each succeeding generation chilled him. Was this, he wondered, why the greenskins never questioned their oppression?

He doubted it. Surely some rebels would arise to challenge the way things were. Or would they? He was thinking in human terms. The strange smells on the breeze, the proportions of the buildings around him, even the ruddy quality of the light reminded him that those did not apply here. In all his dealings with the locals, he had never felt them so alien as they seemed in this quiet little square.

Lost in his thoughts, he missed something Nadab had said. "Your pardon, I pray."

"I said, also to remind us of our separation."

Baasa's aide, Carver knew, was the most prominent greenskin attached to—not *in*—Shkenaz. That did not keep several of the old males from hissing at him in anger—or was it alarm? The trader frowned. Nadab had told him something important. The only trouble was, he was not sure what.

He found no easy way to ask straight out. Maybe changing the subject would let him come back later. He said to Nadab, "I must tell you how much I admire the wisdom you and your people display."

This time, the murmurs from the old males were gratified. "You are most kind," Nadab said. He pointed toward the *Enrico Dandolo*. "Our ignorance is all too manifest, when set beside such achievements as that."

"We are not the proper comparison, though, are we?" Carver asked. "I was thinking of how much more you know than, say, the most learned blue savants of the Empire."

The shot was blind, but it hit. Silence slammed down in the square. Far off, Carver heard a flying hunter screech as it swooped down on something in the not-quite-grass. The old males waited for Nadab's lead. Nadab did not seem inclined to do much leading.

At last the greenskin said, "Come wander with me. We will, I suppose we must, discuss this further." One of the old males spoke in harsh protest, almost too fast for Carver to follow. Nadab said, "Be still, Ithamar. The need is here. This has been spoken of among us, as you know."

"The time is not yet ripe," Ithamar insisted.

"And I say it is. Who has the broader perspective, you or I?"

Ithamar lowered his head and bent his forelegs in respect. "May you be right," he said. He still did not sound as though he thought Nadab was. The rest of the old males left the square.

The building nearest the statue of Peleg was larger than the rest in the greenskin village, and did not look like a home. Carver guessed it might have the same sort of importance in the village as the local governor's hall did in Shkenaz. Pointing at it, he asked, "Is

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that where your people keep the books you do not show the blues?"

"I have never said there are such books," Nadab said. The trader felt his shoulders sag. Whatever Nadab was contemplating, it was not simply opening up to him. Too bad.

"Will you show me what is in there?" Carver persisted.

"Presently, presently." Was that amusement in Nadab's voice? Greenskins seldom seemed amused; they seldom, Carver thought, had much to be amused about. Nadab went on, "Now, as I said, we will wander."

Having no choice, the trader wandered. The village did indeed remind him of a moderately poor chunk of Shkenaz, set outside the city walls. It seemed quieter than such a chunk, but that, the trader thought, could just have been because Shkenaz's big central marketplace went a long way toward making the whole town raucous.

"You see," Nadab said, "that we are no threat to outbid Baasa for your goods."

"You might well be, could you compete fairly with his kind."

"What is fair?" Nadab said, sounding surprisingly like a six-limbed Pilate. Unlike the Roman procurator, he undertook to answer the question, at least metaphorically: "Fair is that all advantages have corresponding disadvantages to make up for them."

"The reverse also has to be true," Carver said harshly. "Your disadvantages are all around me. Where are the offsetting advantages? Those I do not see."

"Well, we are still just walking about," Nadab said. He dipped his head to a male coming by. "Good day to you, Kohath. How does it fare in the city?"

"Much as always, Nadab. Compound interest is such a painful mystery to those caught in its toils." Kohath turned the corner; Carver heard him open a door. On few worlds, the trader thought, would a banker live so modestly. He wondered if that was one of the mysterious advantages of which Nadab had spoken. He doubted it. No one on Ephar made a virtue of abstaining from worldly goods.

More males were coming back from Shkenaz now. Carver glanced at the sky. The sun had slid a long way down toward the west. The trader was surprised when Nadab led him out past the boundary stone and into the fields again. By the look of things, so were the blues who made up the guard squad. They muttered among themselves as the greenskin and Carver walked by.

"Is this safe?" Carver asked. He wished he had his stunner. He hadn't thought he'd need it. Michaels, he knew, would have something sharp to say about showing that kind of confidence on an alien world.

But Nadab seemed unconcerned. "Safe enough, so long as I am back within the village by sunset. Being busy so much, either here or within the walls of Shkenaz, I have too few chances simply to amble this way. When one comes, I make the most of it."

Traveling as he often did for weeks at a time cooped up inside a metal shell, Carver understood that sentiment down to the ground. He said quietly, "Thank you for sharing the moment with me."

"Not to do so would be unjust to the

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one who made it possible,'' Nadab said. He looked from Carver to the *Enrico Dandolo,* a few hundred meters away. ''And, of course, would be inappropriate, as your people have posed the problem now facing me on behalf of mine.''

The trader grew alert. Now we come down to it, he thought. He said, ''We have never intended anything but good for greenskins, Nadab. We want to end your oppression, if we can.''

''That is why, then, you offered Baasa the volumes you did?''

''Certainly. Why else?''

''Who could say, judging beings so strange?'' A nice way to remind me, Carver thought, that I'm as alien to Nadab as he is to me, and a point worth getting across. Nadab went on, ''I thought perhaps your purpose was to destroy my entire people.''

Carver stared. There are times when, no matter how well one speaks a language not his own, he will hear something, understand it perfectly, and still doubt his ears. This was one of those times. The trader spread his hands in a gesture of confusion. ''We wish your folk nothing but good, Nadab. We think it wrong for you to be forced into separation on account of the color of your skin. My own race''—he touched the dark brown skin of his arm—''has too much of that in its own past. Save for your being green and Baasa blue, we know your kind and his are no different.''

It was Nadab's turn to look sharply at the human. ''You know that, do you?'' He astonished Carver by throwing back his head and letting out the strangled snorts that served the locals for laughter.

''What's funny?'' the trader demanded, a bit angrily.

''Only that I came close to confusing skill with wisdom, a mistake I thought myself too wise for.'' The oblique reply did little to soothe Carver's temper. Nadab said, ''Never mind. I see you bear me and mine no malice. Ignorance we shall cope with: we have before, often enough.''

The calm confidence with which the greenskin spoke only nettled Carver further. Somehow Nadab had put the shoe on the other foot, and the trader did not care for it. He was unused to being forced into the role of ignorant outsider, with the local as sophisticate.

''I think we can return now,'' Nadab said. He still sounded, Carver thought, quite full of his own importance. And then, as he turned, that note vanished from his voice. ''Or perhaps not.''

Carver looked back toward the greenskin village. The blue guards had spread into a line between him, Nadab, and the buildings. ''What are they doing?'' the trader asked. But even as he spoke, he knew. His glance went to the sun. Not much daylight was left.

Nadab's head swung in the same direction, then back to Carver. ''Yes, outlander, it is exactly what you think. If I am not on the other side of the boundary stone by sunset—''

''But that's murder!'' Carver burst out. Immediately afterwards, he felt like a fool. Hunting down any greenskin outside his village when the sun went down was murder. He had seen that in gruesome telephoto from the safety of the *Enrico Dandolo*. Somehow, though,

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it had not occurred to him that even that violence might be perverted further by deliberately keeping a greenskin from reaching sanctuary.

Nadab, with 3,000 years of tradition to guide him, had no such naivete. He said, "It happens. From time to time, it happens. Now all that remains to be seen is whether they are out for their own amusement, or have something more in mind."

He walked slowly toward the blue guards. They held their line, positioning themselves so he had no chance of breaking past them back into the village. Carver stood where he was, feeling extraordinarily helpless. He wished he were carryinig a Kalashnikov to mow down the blues, who were waving clubs and spears and yelling threats at Nadab.

The greenskin said loudly, "Let me by. Baasa will not be pleased to learn I have come to harm at your hands."

Strangled snorts came from the blues. "We'll take our chances on that!" one shouted. "That's what you think," said another.

Carver saw Nadab's shoulders sag. Such was what passed for a greenskin's power in Shkenaz: if Nadab's patron tired of him, he was as much at the mercy of the blues as the lowliest greenskin tinsmith.

A small crowd of greenskins had gathered, just on the safe side of the boundary stone. They watched and waited, making no move to help Nadab. Carver was sure they would not. The whole village stood hostage to the blues of Shkenaz. Everyone knew it, greenskins and blues alike. The ritual of death would be played out with no interference.

The lower edge of the local sun's red, swollen disk touched the western horizon. The blues sidled forward. In a couple of minutes, Nadab was theirs in perfect legality. He drew back a few paces toward Carver, not that running would do him any good.

Or would it? That retreat, that pathetic reflex of life trying to prolong itself even to no purpose, broke the trader's horrified paralysis. "Nadab!" he shouted. The greenskin kept his eyes on the blues, but his ears twisted toward Carver. The trader yelled, "Run for our tradeship!"

Nadab stood motionless another long moment. He had, Carver thought, been so sure of his imminent death that he needed time to realize he might live yet. Then he whirled and dashed toward the *Enrico Dandolo*. Carver, slower on two legs than the greenskin was on four but also closer to the ship, began to run too.

The blues shouted in outrage. They were bound in the same web of custom as Nadab, though, and hesitated before giving chase: a sliver of sun still glowed above the horizon. Then it was gone, and they came pelting after Nadab and Carver. The trader heard their three-toed feet pounding behind him.

His chest felt on fire. He was not very young and not very light and not at all used to sprinting cross-country. He did not want to think about what would happen if he stepped in a hole or tripped over a bush. The blue guards might keep right on after Nadab. On the other hand, they might—or some of them might, which would be just as bad—decide to stop and kill him. He hoped that would stay just a thought experiment; he had no desire to test it empirically.

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He also hoped people on the *Enrico Dandolo* were alert. The ground-level hatch was closed. If it didn't open in the next few seconds—he was less than a hundred meters from the ship now, only a few meters behind Nadab and not nearly far enough ahead of his pursuers—things would get embarrassing. They'd get a great deal worse than that for the greenskin.

The hatch slid upward. Relief sobbed through Carver's throat. "Go on!" he yelled, or rather croaked, to Nadab. The greenskin's toes clicked on metal. A moment later, Carver's boots clattered inside the cargo bay.

The hatch came down much faster than it had risen. None too soon—one of the blues was close enough to the *Enrico Dandolo* to hurl his bludgeon after Nadab. It belled off the descending door. Then the guards were pounding on the hatch with clubs and fists. The din was tremendous.

Carver stood with hands on knees, his head lowered, trying to catch his breath. Nadab was panting too, but looked around the cargo bay with lively interest. The fluorescent strips in the ceiling proved particularly intriguing. "Not fire, yet they give light," he said. "Have you then imprisoned glowfliers behind that glass? No, surely not," he corrected himself: "*too bright for that.*"

"They work by the same power as our calculators," Carver told him.

If the trader had expected a surprised outburst, he did not get one. "Ah. Interesting," was all Nadab said. Carver had no chance to take things further. The inner door to the compartment came open. People burst in, shouting questions—mostly variations on "What the hell is going on?"

Carver explained. The crewfolk shouted in anger. The way the Empire treated greenskins was abominable enough without cheating them besides. Patrice Boileau burst out, "We should up ship now, and have nothing more to do with these savages."

"That would not solve the problem," Nadab said. Abrupt silence fell in the cargo bay, punctuated only by the banging from the blues outside. It was not so much for what Nadab said, but for how he said it. Given the limits of his lipless beak, his Trade English was as fluent as anyone else's in the compartment.

Captain Chen, as fit her station, recovered her wits first. "We did not know you spoke our language," she said, adding a moment later, "We did not know anyone on Ephar did."

"I doubt any blues do," Nadab said, again in Trade English.

The humans looked at one another. Lloyd Michaels said to Carver, "Seems we were on to something, there back in Shkenaz a few days ago."

"So it does," the black man said.

"So you were," Nadab agreed.

Captain Chen drove for the heart of the issue, asking, "Why do you choose to reveal this to us now?"

"Because at last I am convinced you do mean well for my people." Nadab sounded as though the question surprised him. "Jerome Carver here would not have risked himself to save me were it otherwise."

"But—" That strangled protest came from everyone in the compartment at the same time. Carver managed to ar-

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ticulate it: "Ever since we came to Ephar, Nadab, we humans have been working to better the lot of you greenskins and help you take your full, rightful place in the Empire."

"What makes you thing those two things are one and the same?" Nadab asked. The only flaw in his speech, Carver thought, was that he sounded pedantic. He thought about that, then reconsidered: another flaw was that the greenskin made no sense at all.

Patrice might have been reading his mind. "How could you not want to be free from persecution?" she demanded of Nadab. "How many of you have died for the sake of hatred?"

"Many, very many," Nadab said, answering the second question first. "We believe, though, that they let us atone for a murder by one of ours long ago, a murder that was surely the stupidest thing a greenskin ever did, and so they are not in vain."

"I don't follow that," Patrice said. Carver nodded; he found it tragic that such a clever being as Nadab should be trapped like a fly in superstition's cobweb.

"In any case," Michaels said, "a cargo bay is hardly the place for this kind of talk. What say we go up to the control room?"

"Good," Captain Chen said briskly. "From there, we can also tell the blues outside to go away, and that Nadab is under our protection."

"That is very generous," the greenskin said, "but what makes you believe they will listen to you?"

"They'll listen," the captain said, her voice grim. "Come along." She led them up the spiral stair to the control room.

"You half-built beings have an easier time of this than I," Nadab complained. He had to twist his body awkwardly all the way up the stairs, and slowed Patrice and Carver, who were behind him.

Captain Chen stalked over to the intercom, flipped a switch to channel it through the outside speakers. "Get away from our ship!" she roared to the blues below. The volume control was all the way to the right; she must have sounded like an angry god. She went on, "Nadab is under our protection. We do not allow you to harm him."

One of the blues ran, hurrying back toward Shkenaz. The rest stayed where they were, though for upwards of a minute they simply stood in place, giving up their pounding on the cargo hatch. Carver thought the noise had stunned them. More attuned to the subtleties of his people's body language, Nadab said, "They do not believe their ears."

When the blues did regain their tongues, he was quickly proven right. "But the greenskin has violated his parole," a guard shouted, and even the humans could hear his incredulity. "He is now ours, to do with as we wish."

"He is not," Captain Chen declared, still at the top of her electronic lungs. "You forced him to stay outside his village past sunset. Otherwise, he would not have."

"What has that to do with it?" the blue yelled back. "The act is all. Had the gods wished him to live, they would not have let us detain him."

"Oh, shut up," Captain Chen snarled, but in Trade English. She clicked off

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the intercom and the outside mike. "Let them scream their fool heads off out there. Eventually they'll get tired and go away."

"No, they will not," Nadab said.

"Well, then, let them have their fit. They can't hurt the ship, and now"—the captain pointed at the switched-off intercom—"they can't bother us any more either." She folded her arms across her chest, glowered at the greenskin. "Now, perhaps, you will start making sense of yourself."

"I am more curious about what you intend doing with me," Nadab said.

"How you answer our questions will make a difference in what we decide, you know," Carver told him.

The greenskin considered. "Yes, that has some truth to it. Very well; ask what you will."

Despite the invitation, the control room stayed silent a moment. Patrice spoke first; working as she did with computers, she was used to breaking down questions into the smallest possible pieces. She said, "Why did you say bettering your people's lot was not the same thing as taking equal part with the blues in the life of the Empire?"

"Because we better ourselves precisely by not taking equal part," Nadab replied at once.

"Riddles," Michaels said. Carver just suppressed an urge to kick him in the shin.

"Riddles have answers," Captain Chen said sharply. She glared at Michaels, who looked away; even the boldest man thought twice about risking her anger. She turned back to Nadab. "Go on."

"I would think the matter obvious," the greenskin said. "As Carver showed me, you people grasp the concept of life's changing over time, depending on the circumstances brought to bear upon it."

"Evolution," Carver supplied.

"If that is your word; I have not met it before. We have been aware of it for something close to 2,000 years ourselves."

The humans stirred. "Longer than we have," Michaels muttered. This time, no one shushed him. He went on, "Our arts were at a much higher level when we first thought of the notion of evolution than yours are now, to say nothing of what yours must have been so long ago. If what you say is true, how did you learn of it so quickly?"

"And what does it have to do with the greenskins' plight?" Captain Chen asked.

Nadab opened and closed his hands several times. "Are you all blind?" he said, in the local language this time. He returned to Trade English. "Think: what restrictions have applied to us greenskins since the one we never name slew Peleg and fled under cover of darkness?"

"*That's* why they don't let you out at night!" Carver said.

"Yes, of course," Nadab said impatiently. "Can you not answer a question without being diverted down a double hand—no, excuse me, you would say half a dozen—sidetracks?"

Carver threw the greenskin a curious look. He saw he was not the only one doing so. Always before, on Ephar, he had felt himself more able, more sophisticated than the locals. Now, though, Nadab seemed in control of things, not

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any human. Taking turns, Carver and his companions spelled out the prohibitions greenskins had to endure: no intermarriage, no owning land, all the rest.

"Enough," Nadab said at last—yes, he was in control. "What sort of lives do we lead, then, as a result of all this?"

"Narrow ones," Carver told him. "Forgive me, but that is the truth as we humans see it. You are restricted to a tiny handful of trades among the many in the Empire, and insecure in your hold on those because you are so vulnerable to the blues." The rest of the people in the control room nodded. Carver pointedly added, "As the events of the day have shown."

"All true, but all, I fear, superficial," Nadab said. "The key is in the sort of—"

The chime of the phone from the weapons turret interrupted the greenskin. Like all weapons officers, Anastas Shumilov always stood his watch there rather than in the control room, so he could aim the guns by hand if the electronics were damaged. Shumilov said, "Captain, forgive me for interrupting, but a fair-sized mob is coming this way."

No one had been paying attention to the view panels. "Oh, dear me," Michaels said, or words to that effect.

"I guess that blue guard wasn't just running away," Patrice added. Her comment, though less colorful than Michaels's, was as inadequate.

Blues with torches, blues with clubs, blues with spears were streaming out of Shkenaz toward the *Enrico Dandolo*. Carver started to worry when he saw locals in bronze helmets: if soldiers were part of the crowd, it all too likely had official sanction. His concern doubled when he saw blues hauling stout timbers, of the sort they would think able to batter down the outer cargo bay door, and doubled again when he spotted Baasa near the rear of the mob—official sanction, indeed.

Nadab said, "If you thwart them over me, they will surely turn on my people's village." Carver was sure bitter experience informed the greenskin's words.

"No they won't," Captain Chen ground out. She spoke to Shumilov: "Wait until the frontrunners are within fifty meters of the ship, then hit 'em with the searchlight."

"Aye, aye." The weapons officer wasted few words. A minute later, the view panels lit up bright as day. Suddenly the blues' torches seemed feeble and insignificant, not the frightening harbingers of fury they had been, blazing in the darkness. The locals came to a ragged halt.

Captain Chen clicked on the outside speakers. "Go back to your city," her amplified voice roared. "The greenskin Nadab is under our protection. We will not let him be harmed."

That blunt announcement set the blues screaming again. They started to surge forward. The captain said, "Do you need to be reminded of what our weapons can do?" The surge collapsed. Tradeships had used their guns a couple of times on Ephar. The most recent was seventy-five years ago. After that, imperial authorities forbade attacks on offworlders. They were too expensive to be worthwhile.

But the locals were still anything but happy. "Give us the greenskin!" they

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shouted. "Let us finish him!" Searchlight or no, weapons or no, the blues hauling the makeshift ram began moving forward.

Captain Chen's jaw tightened. Carver understood her dilemma. Opening fire on the mob would not only ruin the *Enrico Dandolo*'s trading mission, but also cause endless red tape when the ship got back to civilization. Not opening fire, though, would be seen as weakness . . . and there was always the horrible off chance the locals really could break in. Not every ship got back to civilization to worry about red tape.

While the humans watched the head of the mob, Nadab spotted several blues slipping away from the rear. "As I thought," he said. "They will avenge me upon my village."

"What? No, they won't." Relieved at finding an action she could take, Captain Chen snapped an order to Shumilov: "Give me a few rounds of tracers. Shoot to miss, but show them they can't have the greenskins."

"Tracers, aye." Machine guns hammered. They made an ideal weapons system on pre-technological worlds, being both raucous and spectacularly lethal. Lines of glowing red reached across the night. The locals abruptly lost interest in going any closer to the greenskin village. The blues with the ram looked to be having second thoughts, too.

Baasa's retinue pushed through the mob so the local governor could confront the *Enrico Dandolo*. He seemed dubious about the honor of that, but spoke up as boldly as he could: "Send Nadab the greenskin out to us and we will go home. Having broken our strongest law, he must face justice."

"No," was all Captain Chen said.

Carver gestured for the mike. The captain gave it to him. He said, "The toughs outside the village deliberately kept Nadab from returning in good time. What's more, I'd guess they did so at your orders. Now you say he has broken the law. How do you have the crust to call that justice?"

"It is our ancient way, by which we and the greenskins have always lived. The excuse is nothing, the act all. If Nadab was out of his village, he must atone for his guilt."

"As I predicted he would say," Nadab told Carver.

Rage ripped through the black man. He spoke into the microphone again: "It is not our ancient way, and we do not accept it. Go back into Shkenaz; leave us—and Nadab—at peace. You have seen we own the power to enforce our demands. Go back to your homes, all of you. There is nothing for you here." Carver switched off the mike.

Captain Chen eyed the view panel. Hardly any of the blues outside were going home, but they were not advancing on the *Enrico Dandolo*, and they were not heading for the greenskin village: the tracers had effectively discouraged that. "Good enough," the captain said. For Shumilov, she added, "Use the guns to keep them where they are, but don't fire into the mob itself without my order."

"Aye, aye," the weapons officer said, and fell silent again. He talked as though he were afraid his pay got docked for every surplus word he used.

The blues kept milling about without

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doing anything much except beginning to argue among themselves. "Stalemate," Captain Chen said, sounding pleased with herself. "Eventually they'll get bored and leave us alone." She turned to Nadab. "Where were we when that mess started?"

"They will not get bored. They will not go away," the greenskin said, in much the same tone, Carver thought, as he would have said, *The sun will come up tomorrow.* Nadab went on, "As for where we were, I was remarking that the key to our problem lay in the sort of occupations in which we are permitted by law to engage."

Carver admired the way Nadab instantly repaired the broken thread of conversation. The trader started to tick off greenskin jobs on his fingers: "Scribe, banker, jeweler, shopkeeper—"

"You need not go through the entire catalog," Nadab said with a sting in his voice that Lloyd Michaels might have envied. "Far simpler to notice what they have in common."

Again Carver—and, he saw, his companions—danced to the greenskin's tune. Carver rubbed his chin as he thought. Before anything occurred to him, Patrice said, "We were talking about this a while ago, Jerome, remember? More than any other locals, the greenskins live by their wits."

"Exactly!" For the first time, Nadab seemed satisfied with the humans he was facing. He spread his hands in an expansive gesture, then let them drop again when no one picked up what was plainly a cue. "Surely you can extrapolate from what you know."

"We know many things," Captain Chen said shortly—she was losing patience. Her wave encompassed the control room, which anyone on Ephar was centuries from matching. "What in particular applies to you?"

"When I learned you knew of evolution, I did not think I would have to be so elementary," Nadab said. *So there,* Carver thought. The greenskin resumed, "If you are raising livestock and desire a larger beast, what do you do?"

"Breed the largest ones you have to each other." Michaels gave the obvious answer, sounding as if he was humoring the greenskin. "Then breed the largest of the next generation to each other, and—" His voice trailed away. Carver felt a tingle of something between awe and dread as he saw where Nadab was leading the humans. Michaels's voice was more serious than Carver had ever heard him: "You're saying this applies to you."

"How could it not?" Nadab said. Though nothing about him had changed, he suddenly looked vastly different to Carver. The trader would rather have gone on seeing Nadab as a representative of a tormented minority than as the result of an age-long experiment in controlled breeding. Things would have been much more comfortable that way.

"You claim you greenskins have been breeding for brains for all this time?" Captain Chen sounding rattled was as unnerving as Lloyd Michaels being serious.

"Say rather we have been bred for them," Nadab said. "After the crime of the one we do not name, the restrictions you know were forced upon us. They acted as they had to act, whether we knew of it at the time or not. Those

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of us who were clever enough to make their way in the face of such difficulties survived and bred; those who were not starved or were killed on account of their stupidity, either by offending the blues or from being caught out after sunset . . . as I was. Do you doubt now that I am something different from any blue you have known—and from yourselves?"

Before any of the humans could answer, the machine guns' harsh chatter made them all jump. Tracers stabbed into the night, warning the blues away from the greenskin village again. "I do thank you," Nadab said, "but how long will you keep that up? All night? A day or two? As long as you are here? Do you think the blues will have forgotten by that time? They have not forgotten us in 3,000 years."

An ancient joke floated into Carver's mind: *if you're so smart, why aren't you rich?* It rang eerily apt here. The trader said, "If you were what you say you are, Nadab, I'd expect your kind, not the blues, to be masters within the Empire."

Nadab cocked his head; had he had eyebrows, Carver thought, he would have lifted one. "Baasa listened to my advice. After I am gone, he will have another greenskin by his side: we reckon better, we remember better, we pull things together better than any other aides he is likely to find. Do you think him the only city governor who has discovered our usefulness? Do you think the Emperors themselves have not?"

"He's right," Patrice said softly. "Check the records. Every blue official traders have dealt with has always had a greenskin at his elbow." From the way she stared at Nadab, she too was seeing him with new eyes.

"Of course," the greenskin went on, "we also have the advantage of being disposable at need." Was that bitterness? Somehow Carver doubted it. Nadab sounded altogether matter-of-fact. *Alien,* the trader thought.

"Let's say you do rule behind the scenes." Captain Chen had recovered briskness, to Carver's relief. She reached a hand toward Nadab, as if to pull the answer to her next question from him: "Why then haven't you people used your position of power to better your lot and get rid of the burdens you suffer under?"

Nadab drew back a pace; his tail switched up and down, a gesture of dismay. "Because we do not wish to, and we must not. We have been atoning for the nameless one's crime all these years, by making ourselves into a people that will not act so stupidly as he did. If there were no longer pressure to force wisdom upon us, we would fall back into sloth and ease, and cease to improve ourselves."

"That's the craziest—" Lloyd Michaels began, but stopped before he finished the sentence. Carver understood: from the greenskins' point of view, what Nadab was saying was perfectly logical. And intelligence is not always what sets basic premises; it only works from them.

Carver understood something else as well. "That's why you were going to butcher the science books Baasa bought from me. If the blues catch on to evolution, they may realize what you've become."

"What we are becoming," Nadab

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corrected gravely. "But yes, you are in essence correct. I doubt they would approve." Even in Trade English, the greenskin had a gift for understatement.

"How can you presume to speak for all your people?" Captain Chen demanded. "What of those who do not care to be persecuted for the sake of an ancient crime? Don't they want us to do whatever we can to lighten their load?"

"You humans have been coming to the Empire for two hundred years now, your reckoning. In that time, how many greenskins have sought such aid from you?"

"None." The captain did not sound happy about admitting it. Nadab let the silence grow behind that solitary word.

The tracers punctuated it. The humans jumped again. Nadab repeated quietly, "How long will you keep that up?"

"What would you have us do?" Captain Chen's voice was no louder.

"Open a door and let me out."

"No!" Patrice and Michaels spoke at the same time, while Carver said, "They'll kill you out there." Captain Chen said only, "You know what the consequences will be if we do that. Why do you want us to?"

"The consequences for me will be bad in any case. My life is forfeit now, all through the Empire, and I do not care to live outside it. Would you take me to your world with you? Being a curiosity there, the only one of my kind, has no appeal. So I count myself doomed, come what may. I do not wish my village, and perhaps greenskin villages all through the Empire, to be injured on my account."

The captain spoke to the air. "Shumilov, are you listening to this?"

"Aye." The weapons officer's voice was machine-flat.

"Comments?"

A moment's pause, then Shumilov said, "He's right."

Captain Chen made a sour face. She turned back to Nadab, repeated, "You know what will happen to you out there."

"Yes: the same as would have happened had I let the blue guards have their sport with me at sunset."

"You don't *want* to live," Carver said harshly.

"Of course I do. Who does not? Why would I have run for your ship here when you cried out, if I did not want to live? I thought you were giving me a new option, one none of my people ever had before. But"—the greenskin waved at the view panel that showed the mob of blues—"I see that is not so. I was wrong."

He sounded so downcast at the admission that Michaels asked, "Do you want to go out there and die just to punish yourself for making a mistake?" At first Carver thought his fellow trader was letting his sardonic imagination run away with him; then, looking at Nadab, he wondered if Michaels hadn't hit it dead center.

All Nadab said, though, was, "My people are more important than I am. I have my duty to them. You outlanders have a word for the concept; do you not recognize it?"

Carver winced. So did Captain Chen. She said, "I have another duty also: not to send anyone out to certain death."

"You do not send me. You merely

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let me go. And if you do not, you condemn the greenskins in my village and others you have never seen to a fate worse than mine."

Anastas Shumilov fired off another burst, the longest one yet. "They're getting harder to convince," he remarked.

You may also end up slaughtering a good many blues who have done you no harm," Nadab said.

"How can you sympathize with *them?*" Carver said. "After all they've done to your people—"

"They are the instruments of our improvement," the greenskin said mildly. "Does the raw clay hate the kiln that burns it to make it into a vase?" Nadab swung his unwinking eyes to Captain Chen. "Now will you let me do as I must do?"

"Damn you." The captain turned on the control board as if it were an enemy, stabbed a button with wholly unnecessary violence. The door to the stairwell that led down to the cargo bay slid open.

Captain Chen said nothing more. If Nadab's so smart, Carver thought, let him figure that out for himself. He was; he did. Without hesitation, he started down the stairs. His voice floated up after him: "My people are in your debt."

"Oh, shut up," the captain muttered. She watched Nadab's progress on the ship's internal monitor. He went straight to the cargo bay's outer door. Captain Chen made him wait several minutes. At last, still shaking her head, she let the door rise.

The outside mikes picked up the roar the blues let out when they saw Nadab. It sent atavistic chills racing up Carver's spine; though he had never seen one, his glands screamed *lion*. The instant Nadab was outside the ship, Captain Chen sent the cargo bay door slamming shut.

Like the tide rolling in, the blues surged forward. Nadab did not die tamely. He sprinted for the greenskin village, like an antelope trying to break through a hundred prides of big cats. He still had that one chance in ten billion of winning to freedom.

He never got fifty meters from the *Enrico Dandolo*. The blues dragged him down, took their vengeance on him—and then on his corpse—for his presumption. Carver made himself watch it all, even when the flames sprang up. His only consolation by then was that Nadab could not possibly be feeling what was going on any more.

Once they were done amusing themselves with Nadab—or once there was nothing left to amuse themselves with—some blues started for the greenskin village. Quite without orders (in itself unheard of before), Shumilov fired a burst to ward them back. To his credit—not that any human was ready to give him much—Baasa had the Shkenaz garrison keep the mob away. At last the blues began drifting back toward the city.

"Poor bastards," Michaels grunted. "Some of 'em'll be all tired tomorrow, from working so late tonight."

Carver threw himself into a chair, buried his face in his hands. Patrice touched his shoulder. "You did everything you could, Jerome," she said gently. "You cannot blame yourselves that things here are different from what we thought. What can you do for people

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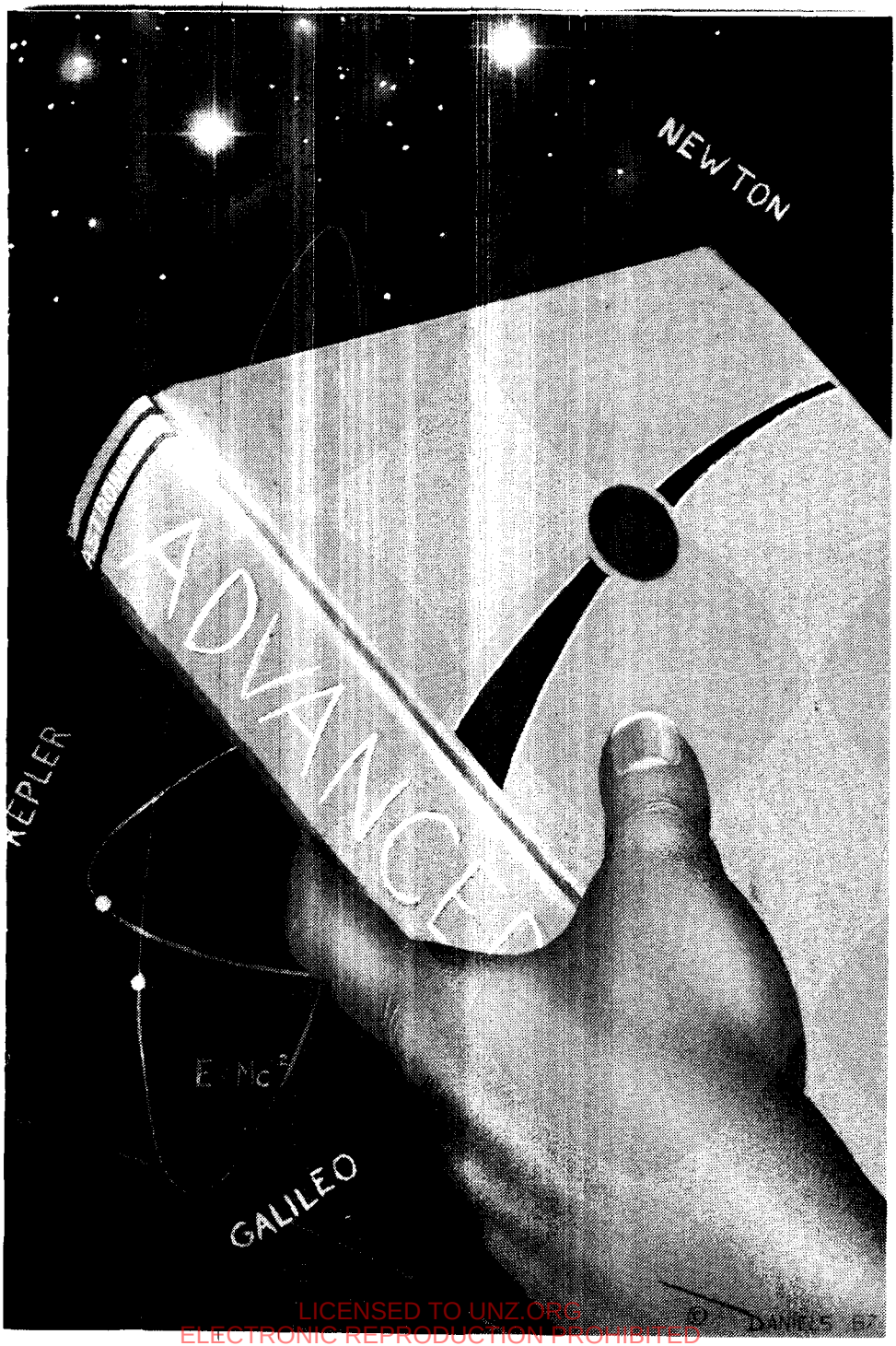

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who have their own reasons, ones they find good, for not wanting their lot to change?"

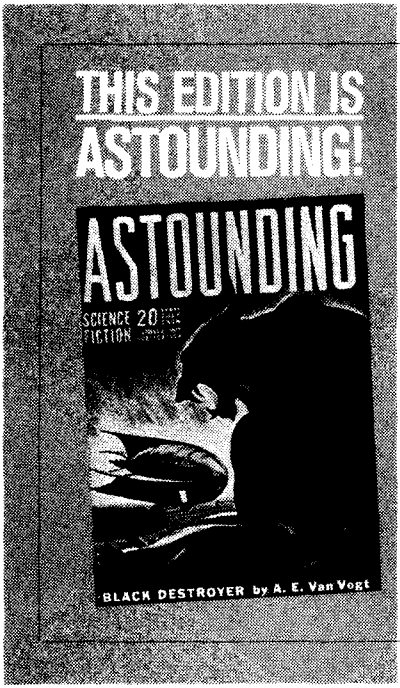
He sat and thought about that for a long time. He knew Patrice meant the answer to her question to be *nothing*, and that she had spoken mostly to lift him from his gloom. He was grateful to her for that. But her words sparked something in him that perhaps had not occurred to her.

He got up and went to his cabin. When he came back, he was carrying a large, fat codex. "What do you have there?" Captain Chen asked.

"An astronomy text, based on Kepler and Newton. I intended to use it as a follow-up to the Galileo; it has the math to carry the blues forward from there."

"Intended?" Not for the first time, Carver remembered that Lloyd Michaels was too good a trader to let much get past him. "What will you do with it now?"

Carver threw the book down the disposal chute. "Call it a last favor for Nadab," he said. He walked out of the control room again. ■



The July 1939 edition of ASTOUNDING Magazine (later to be called ANALOG) is one of the premier issues of the golden age of science fiction. This masterpiece edited by John W. Campbell contains early seminal work by Isaac Asimov and A. E. Van Vogt plus fine pieces by the classic science fiction authors of the day and much more. We are proud to offer this exquisite facsimile, hardbound edition, printed on fine paper as an elegant keepsake of this great era.

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Arthur C. Clarke

ON WEAPONRY

The subject of war disgusts me, and I am deeply suspicious of anyone who appears to be fascinated by it. But men I greatly admire have done so; by a quite startling coincidence, I came across this very relevant quotation just as I was beginning this essay:

> Before 1914, Wells, like many of his generation, had been interested and excited by war. He had written on it at length, demanded the application of science and technology to military preparation and fought his "little wars" with toy soldiers. . . . The Great War changed his attitude to war, like those of so many others, to revulsion. He never again wrote of war with his pre-1914 enthusiasm or his pre-1914 detail and length. He ended his "little wars." After 1918 he wrote against war, repeatedly. He warned against the fascination he had formerly felt. He condemned the application of science and technology to war.*

I appear—quite unconsciously—to have followed in Wells's footsteps (not for the first time . . .). In 1946, my *Royal Air Force Quarterly* essay "The Rocket and the Future of Warfare" explored all the possibilities opened up by the advent of the V.2 and the atomic bomb. It ended with the paragraph:

> One returns to the conclusion that

* Stearn, R.T., The Temper of an Age: H.G. Well's Message on War, 1914 to 1936, *The Wellsian*, 1985, 8:9-27. For further information: Hon. General Secretary, The H.G. Wells Centre, Department of Language & Literature, Polytechnic of North London, Prince of Wales Road, London, NW5 3LB England.

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the only defense against the weapons of the future is to prevent them ever being used. In other words, the problem is political and not military at all. *A country's armed forces can no longer defend it: the most they can promise is the destruction of the attacker.*

The writer Thomas Heppenheimer recently reviewed this now forty-year-old essay and commented: "It was over fifteen years before the doctrine of Mutual Assured Destruction became U.S. policy; yet its essential concept is not only set forth clearly in this article, but emphasised."

To have invented MAD is not one of my prouder achievements (this is what's known as British understatement); perhaps this extract from an address I gave (by videotape) to the MIT Club of Washington in May 1985 may do something to redress the balance:

> We have already met Darth Vader—and he is us. If we are to survive, we must exorcise the demons of our haunted childhood, and grow out of our fascination with "technoporn"—gleaming weaponry and beautiful explosions. Whatever new armaments may be needed to preserve peace in the immediate future, in the long run only political solutions can save us. (If we deserve to be saved; perhaps a species that has accumulated four tons of explosive *per capita* has already demonstrated its biological unfitness beyond further question.)

There have been times and cultures in which it was unthinkable (and frequently unwise) for a gentleman to appear in public without a weapon. In civilised societies, that need has passed. What now applies to individuals must one day apply also to nations . . . who, after all, are only collections of individuals. (Remember Auden: "There is no such thing as the State.") And for better or for worse, human nature is infinitely changeable—a fact seldom understood by the crackpot realists who often prowl the corridors of power.

In the long run—no, the very short run—we have to become intelligent mammals, not turn ourselves back into armored dinosaurs. To complete that quotation from Auden: "We must love one another or die." And it's very hard to love people who—for excellent reasons—we don't like.

But the alternative is far worse. ■

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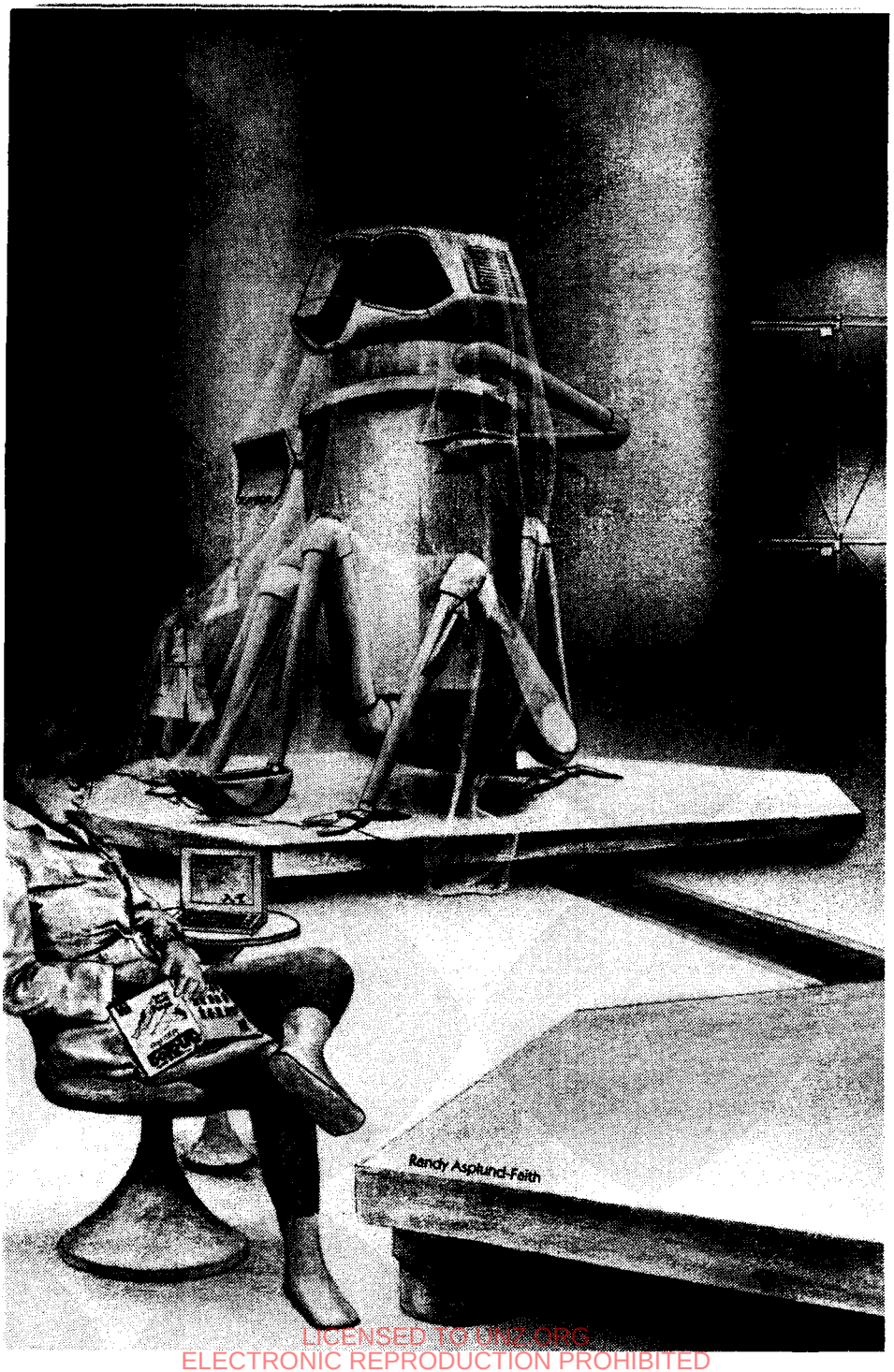

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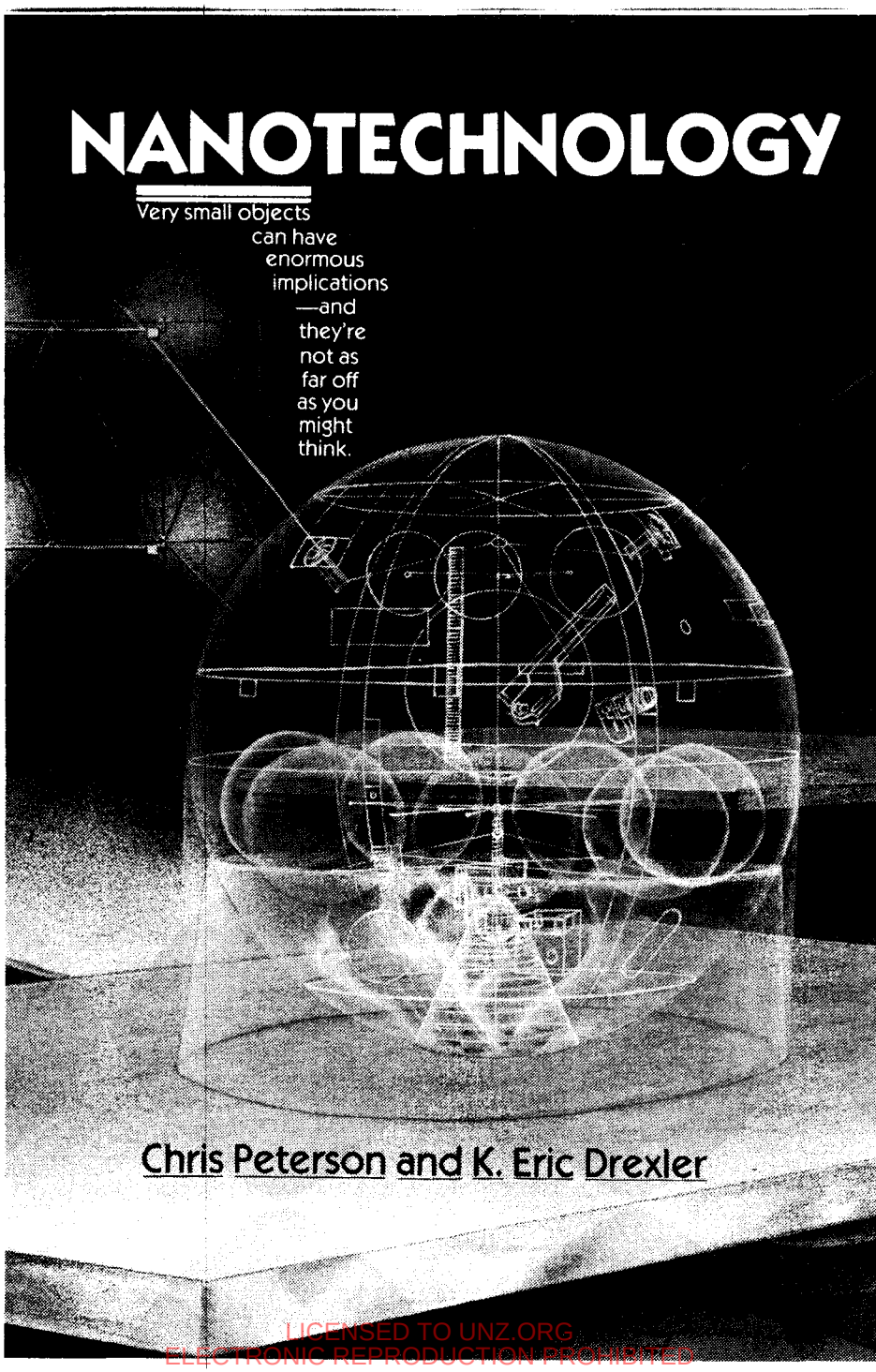
NANOTECHNOLOGY

Very small objects can have enormous implications—and they're not as far off as you might think.



Chris Peterson and K. Eric Drexler

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Today's technology for arranging atoms is crude—we cannot rebuild a ton of graphite into a ton of flawless diamond, nor can we rearrange a cancer cell's atomic patterns to make it healthy. Even our microtechnology slings atoms around in unruly herds. The heating, sawing, etching, and spraying techniques we use to make integrated circuit chips give us feature sizes thousands of times wider than an atom.

But we are beginning to move from this bulk technology to a molecular-level technology which will enable us to place each atom where we want it. Call this ability *nanotechnology*, because it works on the scale of a nanometer, one-billionth of a meter.

To get a feel for technology at this scale, remember that atoms are objects: spherical in shape, a few tenths of a nanometer in diameter, and able to make sturdy connections with other atoms. Recall how the properties of materials result directly from the nature of these connections—picture the long "strings" of atoms in a piece of rubber as they stretch out and then recoil; picture the rigid framework of atoms that forms hard, brittle glass. Realize that tiny machines could be built using individual atoms as working parts. Then remember that such machines already exist.

Natural Nanomachines

The nanomachines found in living things operate on much the same principles as larger machines: they just have very small parts. Lately our abilities to exploit these existing machines—once limited to such things as making cheese and wine—have grown into the industry called genetic engineering. This suggests one path to full-fledged nanotechnology.

Genetic engineering is mostly used to make proteins. We've learned to use chemistry to synthesize DNA "instruction tapes," to use enzymes to splice them together into working genes, and to transcribe these into RNA "tapes" using more enzymes. Finally, we use an impressive piece of nature's nanomachinery: The ribosome, a programmable molecular construction machine. It reads RNA tapes and bonds amino acids together in the order the tapes specify, thereby making a specific protein molecule.

To make industrial quantities of these proteins, we use preexisting collections of nanomachinery, available everywhere, and dirt cheap—bacteria. Some industrial proteins are enzymes, nanomachines which catalyze chemical reactions. They can work fast—some can handle up to a million reactions per second.

Machine Parts

Other natural protein machines include the linear motor of muscle and the rotary motor (or "proton turbine") some bacteria use to drive their propellers (yes, that's how bacteria swim). The T4 phage—a virus which attacks bacteria—works like a spring-loaded hypodermic needle when it injects its DNA; it looks like something out of an industrial gadget catalog. Protein structures already serve as moving parts, bearings, and even motors—everything

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needed for building complex machinery.

The T4 phage demonstrates another ability we will use: when its component proteins are stirred together in a test tube, they stick together selectively and automatically self-assemble into complete viruses. Self-assembly is the key to building complex molecular machines from simple proteins.

The first steps toward nanotechnology are already being taken by protein chemists: they have begun to design new proteins. Only a short time ago this seemed an almost impossible task —although we can control the amino acid sequence of a protein, its function depends on how this linear sequence folds up into a three-dimensional shape, and folding has been hard to predict.

Scientists have had reason for pessimism about predicting a protein's folding pattern: they work with natural proteins, which were never designed to be predictable. Engineers, however, face a different problem: they can focus on designing proteins that *do* fold predictably. Protein engineers are starting to meet with success.

Other Paths

Protein engineers aren't the only ones working on the road to nanotechnology. Research on molecular electronics (what the media calls "biochips") is underway around the globe; success will involve the ability to build things to atomic specification. Likewise, nonprotein chemistry and advanced micromanipulators may help in developing molecular machinery.

In 1959, physicist Richard Feynman touched on a parallel idea in a talk: he spoke of using small machines to build smaller machines (and these to build smaller machines, and so on). He observed that "The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom," and went on to remark: "But it is interesting that it would be, in principle, possible (I think) for a physicist to synthesize any chemical substance that the chemist writes down. Give the orders, and the physicist synthesizes it. How? Put the atoms down where the chemist says, and so you make the substance." (Feynman also said that these substance-synthesizing machines "will be really useless," because chemists will be able to make whatever they want without them!)

Today, we can see several paths to molecular-scale machinery, and we can describe how these machines can be used to make far more than just chemical substances. One path—protein engineering—is guaranteed to work and is already being funded for the sake of its short term payoff. Regardless of the route, our destination is clear.

Driven forward by incentives ranging from commercial to medical to military, protein design and related efforts are sure to continue. Where will these efforts lead? A key goal of molecular engineers will be to build a programmable machine that will work like a ribosome, bonding small molecules onto a workpiece according to instructions encoded on a molecular "tape." Like the ribosome, it will completely control the ar-

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rangement of atoms in its products. Unlike the ribosome, it won't just string amino acids together into chains: it will use a wide variety of building blocks, and put them together in a wide variety of ways. Thus, it will let engineers build non-protein products—including second generation nanomachines. Call it an "assembler." It will begin a revolution.

Objections

Before going further, two concerns should be addressed, either of which could undermine the case for nanotechnology. First, does the uncertainty principle of quantum mechanics make nanomachines unworkable? This principle makes electron positions uncertain and hard to control on an atomic scale, but nanotechnology works with entire atoms, which have much better defined locations in molecules. Second, do the thermal vibrations of heat jostle atoms enough to make nanomachines unreliable? Engineering calculations indicate that thermal vibrations place real limits on what can be done, but the limits are tolerable. One need not check the math to be sure of these answers: to meet both of these objections one need only point to the existence proof of existing nanomachinery. It *can* be built because it already *has* been built, by nature.

Heat does cause special problems for proteins, though: too much heat causes protein machinery to denature and lose function (ever burn a finger?). Too little heat causes it to freeze. Further, proteins must be in water to work properly. The fragile, finicky nature of protein makes it difficult to work with; as soon as we can, we will use our protein machines to build rugged non-protein nanomachines.

Assemblers

First-generation assemblers (however they may be built) will soon be used to build second-generation assemblers. These will be improved devices for assembling molecular structures, resembling industrial robot arms, but built on a vastly smaller scale. More robust than protein machines, they could be designed to tolerate extreme conditions; acids, vacuum, freezing, baking. They will use as tools the same reactive groups used by chemists, but will be able to apply them precisely where needed. Since they will use atoms as building blocks, they will operate in a world full of perfect, ready-made parts.

These assemblers will be able to bond atoms into virtually any stable pattern. With them, we will be able to build almost anything the laws of physics permit to exist, almost anything we can design.

One submicron-size assembler, or even a few working together, would take ages to build a macroscopic object. Instead, we will first have them build copies of themselves, replicating to enormous numbers. Given raw materials and energy, they will multiply exponentially and then cooperate in building large objects. Using atoms from dirt and energy from sunlight, they could build immense quantities of anything from houses to hamburgers to spaceships.

Making smaller, faster computers will be an important application of

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nanotechnology. Instead of spraying thousand-atom-wide ribbons of metal onto flat wafers, we will use assemblers to build three-dimensional circuits to atomic precision. The physical limits to computation are unknown today, but wherever they are, we'll reach them by using nanotechnology to build atomically perfect structures.

Mechanical Nanocomputers

The first nanocomputers may work mechanically, not electronically. We don't need new scientific understanding to design mechanical nanocomputers; we don't even need to use much quantum mechanics. They can be designed using Newtonian mechanics, along with known constants such as the size and mass of various atoms and the strength and stiffness of molecular bonds.

With a logic mechanism based on moving atomic-scale rods, a mechanical nanocomputer with a billion bytes of storage will fit into a cubic micron—just one-thousandth the volume of a human cell. Memory access times will be in the nanosecond range for fast memory, and in the microsecond range for tape memory (the tapes are very short, and take little time to rewind). Using the same basic design we should be able to put the computational capacity of the human brain into less than a cubic centimeter. Electronic nanocomputers will probably be faster than equivalent mechanical designs, but may not be smaller. Radiation damage becomes a real constraint for devices built on this scale; we'll need to include repair capabilities and redundancy to get high reliability.

Limits

With nanotechnology we'll have greatly increased computing power and the ability to build to atomic specifications. Given the proper atoms and sunlight, we will be able to build any stable arrangement of atoms, limited only by our powers of design and by physical law.

The consequences of nanotechnology are so boggling that it is sometimes easier to focus on what it *cannot* do. It won't let us turn lead into gold, or any element into any other: that would require changing the atomic nucleus, and nanotechnology works at the level of whole atoms. Nuclei are far too small and "hard" to be altered by lugging large, fuzzy atoms back and forth.

Similarly, we won't be able to use nanomachines to build smaller machines made up of nuclei. In fact, nuclei are so mutually repellent that building anything complex with them would be impossible (at least outside a neutron star); the parts would instantly fly apart.

Nanotechnology won't let us travel faster than the speed of light, or backwards in time, or let us control gravity (except in the usual way, by moving large masses around). Nanotechnology will simply let us exploit the unchanging—but impressive—possibilities inherent in natural law. Because we and everything around us are made of atoms, we should expect striking consequences from an ability to put each one exactly where we want.

Working at the atomic level doesn't limit this technology to fabricating small objects: the existence of whales shows

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that nanomachines can build big. To see how molecularly-engineered materials would make a difference, look at the space frontier, where strong lightweight materials play a key role.

Space Applications

Consider diamond. Made from carbon atoms in a regular lattice connected by standard single bonds, diamond is one of the simplest and strongest materials. Today we can make it only in tiny bits.

Building this lattice wouldn't require a programmable assembler—a simpler enzyme-like machine could layer carbon atoms into place one by one. By laying down atoms in the right pattern, such a machine could produce strands of fine, flexible diamond fiber. They would have about fifty times the strength-to-mass ratio of aluminum and would be useful for advanced composites in planes and spacecraft.

The real potential of nanotechnology appears when we consider using it to build larger objects. Nature illustrates how to construct a large object from the molecular level up: growing animals and plants use a vascular system to transport needed construction materials and devices. We already follow this model in constructing buildings, using the corridors and elevators of unfinished structures to bring in more materials. Assemblers making large objects could do likewise, constructing a scaffolding and using channels to move in the materials needed for the job.

Building an Engine

Picture how such a process might be used to "grow" a large rocket engine. Although the assemblers could be designed to work in vacuum or dry air, we'll find it convenient to have them work in a fluid which can carry in materials and carry away waste heat. The entire construction process could take place in a steel vat large enough to hold the finished engine. Pumps and pipes are connected to the vat, circulating various fluids as they are needed.

As we watch through a window in the vat, the process starts: a "seed"—a nanocomputer holding the plans for the finished engine—is lowered into the vat, then the first fluid is pumped in. This fluid is viscous and opaque because it is a suspension of many trillions of assembler systems, each including an on-board nanocomputer. Following their programs, these assemblers bond to the seed, building up layer upon layer, like a growing crystal.

As the assemblers bond on, the seed passes new instructions to them; they form a connected solid network which is able to pass along instructions to new members as they join. These messages tell each assembler its location in the structure and whether it should invite still more assemblers to join the structure, to extend it in a particular direction. The structure grows into a translucent engine-shaped block of assemblers.

The fluid containing the excess assemblers is then washed away by a new fluid, containing needed materials. Dissolved compounds can be broken down by the assemblers to release aluminum, carbon, oxygen, and energy. The assemblers also need room to work, so the

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seed now directs most of the assemblers to leave the structure. They stream out, opening up corridors and capillaries. Through a window in the vat we see cloudy fluid billowing out of the engine-shape. Only a delicate, transparent scaffolding remains—we can barely see its outlines.

Now tiny flagella-like appendages on the remaining assemblers help sweep fluid through the capillaries, carrying fuel and raw materials. The assemblers now have instructions provided by the seed, and materials, power, and cooling provided by the fluid. They begin work.

For engine parts needing high strength, assemblers bond carbon to form diamond. They build a dense mesh of fibers rather than a simple crystal structure, making a tough composite instead of a brittle crystal. Where heat and corrosion resistance are required, the assemblers bond aluminum and oxygen atoms to form a similar composite of sapphire. Some parts of the structure are lightened with a honeycomb of voids; others, to withstand higher stress, are nearly solid. As the assemblers finish their work, fine channels remain in even the densest parts. The assemblers make their retreat through these, pumping out and sealing up chambers as they go.

Thus the assemblers construct the pipes, pumps, sensors, motors, and other engine parts, including any onboard computers. As each one finishes its work, it escapes and lets go of the engine, floating away into the surrounding fluid with its teammates. Finally, the fluid is drained and the finished engine hoisted out; the entire process has taken less than a day.

This engine is very different from those we build today—it has no nuts and bolts, no seams. Its surface is smooth, with an opal-like translucence that results from voids with spacings like those of the pits on a laser disk. Made of materials far better than metal, its mass is a few percent of what a modern engineer would expect.

At this point, spectators might expect the finished product to be shipped under heavy guard to an art museum, but instead it goes into routine launch service. Even under heavy use, it will last a long time. Microcracks won't spread, due to its fibrous construction. Better yet, strong materials and near-perfect fabrication will allow wide safety margins and high reliability.

The alert reader may have noticed that the description above doesn't exploit nanotechnology fully: for example, the engine could have been built by assemblers working inside an extensible "skin," building a vascular system as they went along, instead of using clumsy pumps and a vat. Worse, the finished engine didn't even contain any nanomachinery to keep it in good repair, or to reconfigure it for varying uses. Why not make the structural fibers more like muscle fibers, able to extend and contract to change the engine's shape? Why not have assemblers on hand to build entirely new parts as needed?

The Ultimate Spacesuit

Imagine a small person-carrying spacecraft—a spacesuit—made with nanotechnology. It could have an active

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structure with artificial muscle, made of diamond fiber and directed by nanocomputers. While wearing it in a *g*-field, you wouldn't notice the suit's mass, since the suit itself would support its own weight—and yours as well, if desired. It would have the strength of steel, but still be flexible. It could act soft or hard as desired.

The suit's active structure could be programmed to amplify your movements, making you stronger, or to blunt impacts from outside. It could sense the textures of objects it touched, and transmit them to your skin. Like a plant, it could use sunlight to convert the wearer's carbon dioxide exhalations into fresh oxygen. The suit could be compact and tight-fitting, yet still have enough volume for redundant systems, capable of self-repair.

Resource Needs

We'll need energy and raw materials to build all these atomically-specified materials and products, but supplies are plentiful. Plants demonstrate that solar energy is sufficient to build molecular machines, and the Sun pours out thousands of tons of light per capita per year. Today's experimental solar cells already have higher energy conversion efficiency than plants. With nanotechnology we can probably do better.

There will be no need to chew up Mother Earth to get the atoms needed—we can use the asteroids. They can supply over a hundred million tons of material per capita, including carbon, nitrogen, oxygen, hydrogen, aluminum, nickel, iron, silicon, and platinum group metals. From these we can build anything we want, from consumer products to space settlements. Using the asteroids alone we could build 1,000 times Earth's surface area. With strong materials made using nanotechnology, each O'Neill-style space settlement could have the area of North America.

Fast Interstellar Travel

For getting around between our settlements, we can use lightsails—giant solar sails with reflectors a hundred atoms thick—which move by the pressure of sunlight and tack using gravity. But these are too slow for interstellar travel; they would take millennia to reach the stars on sunlight alone. We could use giant banks of lasers orbiting the Sun to push lightsails toward the speed of light, but getting them to stop at the other end presents a problem.

Robert Forward suggests sending a sail that can split into two sails, the first unloaded, the second carrying cargo. When the time comes to stop, we would direct the lasers so that their light bounces back off the first sail toward the front of the second one, slowing it. The first sail would speed off, and be discarded. This requires that the first sail have good optical quality. A tension structure actively controlled by nanocomputers and supporting a thin-film reflector should do the job.

Another approach would use nanotechnology more extensively. Take a one-ton lightsail made of a transparent material, able to endure intense laser light. Use the lasers to accelerate it at many *gees;* it reaches over 90 percent of the speed of light in well under a

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year. Once it is up to speed, onboard assemblers rebuild it into a long, thin, traveling-wave electrostatic accelerator. This forms a tube 1,000 kilometers long, with a mass of a gram per meter. The cargo, containing a cubic micron of material, forms a shell a few microns in diameter.

As the tube flashes past the target planetary system it fires its cargo backward, leaving it almost stationary but moving toward a planet with an atmosphere. It hits the atmosphere, using it to brake, while the shell radiates entry heat to keep the cargo cool.

The tiny cargo—an assembler/nanocomputer system—immediately starts building. (All known atmospheres contain carbon, which is enough to build a grain of stuff heavy enough to fall to the surface.) These replicating assemblers build a receiver to pick up instructions beamed from home. They could be directed to build rockets and explore the system, or to build a bank of lasers to brake a passenger ship now on its way. With this system, humanity could expand its occupied sphere at near the speed of light.

A Dumb Path to Artificial Intelligence

We can be sure that during this expansion, we will have artificial intelligence to help us. If we don't have genuine AI before the assembler breakthrough hits, we'll have it fairly soon afterwards, because nanotechnology will enable us to use a brute force method.

Back in the 1950s and early '60s, some AI researchers tried neural simulation: using computers to physically model the brain. At the time, software approaches to the AI challenge looked more promising, and they may yet produce AI before the assembler breakthrough. If not, neural simulation will still work (it must work, if done well, because brains work). Research in artificial neural systems is coming back into fashion, with often striking results: one machine with a few hundred simulated neurons learned to read English text aloud with 95% accuracy after ten hours of learning—and it had no knowledge of English programmed in. It understood nothing, of course, but machines that understand seem sure to come.

No fundamental new insights into the nature of thought will be needed to achieve artificial intelligence via neural simulation. We can use nanotechnology to study the brain down to the molecular level. Then we could transpose the neural patterns into devices that act like neurons, but faster. If done correctly, the system will work like a brain, but faster.

A crude estimate of the speed increase is easy to make. The brain's neural response time is about one-thousandth of a second; today's experimental electronic switches are 100 million times faster. (Nanoelectronic switches should be even faster.) The human brain's neural signals travel at under 100 meters per second; electronic signals travel a million times faster. Thus, a rough guess would be that the artificial brain will work a million times faster than a human brain.

Moreover, the parts are smaller, so the whole thing will be more compact. We should be able to fit a brain-equiv-

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alent device into less than a cubic centimeter. When these shorter signal paths are added in, we find that the system should be 10 million times faster than a human brain. It would also use far more power than a brain, requiring a good water-cooling system. There's no reason not to connect a number of these brains together. John McCarthy points out that if we can put one mind-equivalent in a metal skull, we can fit 10,000 cooperating minds in a building.

Before we succeed in modeling the brain, we should be able to build powerful engines of design to do automated engineering. Already we have expert systems, computer-aided design, and programs like EURISKO, able to evolve new rules for themselves. Eventually engineers will be able to propose goals and then choose among solutions generated by computer.

When automated engineering is combined with brainlike devices made by assemblers, technical ideas will evolve a million times faster than today. With assemblers to construct the resulting designs, technical advance will skyrocket. Goals that seemed physically possible but a million years away will be achieved in a matter of months.

Repairing Human Cells

With good technical AI and assemblers, many complicated tasks will become easy. Take medicine: today physicians dump drugs into the body, cut it apart and sew it together, but to actually heal damage, they must ultimately rely on the body's capabilities for self-repair. Nanotechnology will allow direct repair of cells, producing molecular-scale effects, like drugs, but with precise, surgical control. With a combination of technical AI and disassemblers—assemblers working in reverse, taking apart objects to analyze them—we will study the structures of all of the body's molecules and cells. Nature already demonstrates the needed abilities: access to the cell, and the recognition, disassembly, rebuilding, and reassembly of biomolecules.

Call these repair devices *cell repair machines*: as small as bacteria or viruses, they will examine, take apart, and rebuild damaged molecular structures. Complex cell repair machines will need *on-board nanocomputers*. These micron-size mechanical computers will be able to hold more information than the cell's DNA. They will direct simpler, smaller computers which operate the machines that manipulate biomolecules.

To visualize their relative size, bring the whole system up to a larger scale. If atoms are the size of marbles, atom-manipulating tools are like fingertips. A single repair device with a small computer is the size of a truck. A large, cubic-micron computer is thirty stories high and a football field long. The cell itself is a kilometer across: the cell repair machines will have plenty of room to maneuver.

Any physical problem—cancer, infectious disease, arteriosclerosis—could be fixed by such machines. Repairing DNA would be easy: simply compare enough strands to be sure of the correct sequence. In effect, cell repair technology will place our minds in final, com-

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plete control of our bodies.

Very Long Lifespans

Life extension is a natural consequence: the process of aging will become reversible. We need not study the aging process and how to help the body repair itself, as we do today; instead we can study healthy young tissue and how to bring older tissue to this state. We will need to use many cell repair machines in parallel to make the overall repair process fast enough. Although death remains inevitable, these techniques will bring indefinite life extension. Moreover, this brute-force approach to medicine would presumably allow a cure even for severe, long-term, whole-body frostbite.

When Will Nanotechnology Arrive?

Don't let these dramatic consequences mislead you into thinking that this revolution is far off. Cell repair machines—and their software—will be *extremely* complex, but assemblers and nanocomputers need be no more complicated than industrial robots and microcomputers. Research is underway: Japan, the U.S., Europe, and the Soviet Union are all working on protein engineering and molecular electronics.

In October 1986 the U.S. Naval Research Laboratory held the Third International Symposium on Molecular Electronics, drawing contributions from around the world, including Japan, West Germany, France, Italy, England, Australia, Argentina, Yugoslavia, and the USSR. (The authors from the last two countries failed to appear.)

The field is so new that information for laymen is scarce. Most published material is in the form of technical papers and conference proceedings on developments leading toward nanotechnology; few are about assemblers and nanotechnology itself. *Engines of Creation*, written by one of us (Drexler) and published by Doubleday, is the first book to describe nanotechnology and its consequences. Not all of these consequences are pleasant.

The dangers are clear when you consider the weapons one could build using nanotechnology. Tough, omnivorous "bacteria" could spread like pollen, consuming the biosphere in days. This has been termed the *gray goo problem*. This is unlikely to happen by accident, but it could happen by malice. There is no more reason why an industrial replicator should be any more able to survive outside a vat of special chemicals than a person is able to survive without air or water.

More likely, though, are military or police applications. Imagine programmable "bacteria" for germ warfare, or a world bugged with things much like bugs, or other, more nauseating possibilities. Accidents seem less likely than abuse, and abuse may be justified as a way to avoid accidents.

We face opportunities and dangers beyond any we have yet encountered. The global technology race makes the advance to nanotechnology inevitable; no one is in a position to cry "Halt!" with any effect. We must seek a path forward, to seize the opportunities and avoid the dangers. There is reason for

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hope and reason for fear, but most of all there is reason to try to understand our situation and our choices, and to try to spread that understanding as wide and as fast as we can. If we fail, our future will be short and bitter; if we succeed, our future will be rich and broad beyond past dreams. ■

Additional Reading

Engines of Creation by K. Eric Drexler, Anchor Press/Doubleday, New York, 1986 hardcover, 1987 paper.

About the Authors

Chris Peterson is an editor, writer, and consultant, concentrating on technological issues. Formerly editor of the *L5 News*, she is a director of the National Space Society and the Foresight Institute.

K. Eric Drexler is a researcher concerned with emerging technologies and their consequences for the future. Author of the first technical paper on nanotechnology, he founded the MIT Nanotechnology Study Group and wrote *Engines of Creation*, a book that describes the prospects ahead and some strategies for dealing with them. He is a visiting scholar at Stanford and a research affiliate of the MIT Artificial Intelligence Laboratory.

●The human race, to which so many of my readers belong, has been playing at children's games from the beginning, and will probably do it till the end, which is a nuisance for the few people who grow up. And one of the games to which it is most attached is called, "Keep tomorrow dark," and which is also named (by the rustics in Shropshire, I have no doubt) "Cheat the Prophet." The players listen very carefully and respectfully to all that the clever men have to say about what is to happen in the next generation. The players then wait until all the clever men are dead, and bury them nicely. They then go and do something else. That is all. For a race of simple tastes, however, it is great fun.

G.K. Chesterton

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on gaming

Matthew J. Costello

First a word of caution about this month's column.

It deals, unfortunately, with matters not exactly free from my self-interest. In fact, it touches on so many areas where I have a personal concern that you may just want to skip this piece altogether.

Except that what I'm gonna talk about (whether my little old self is interested or not) happens to be something that is: (a) the right and true province of this column and (b) something that I'm more than knowledgeable about.

So, all disclaimers properly launched, let's plow on.

The subject is game novels. Yes, that's right, that new uncomfortable offspring of the solitaire game and the novel that, in case you haven't looked, everyone is rushing to put on the shelves.

I've already written two of these, and I'm contracted to do two more. And not without a bit of guilt.

At first I kept them, in my mind at least, separate from my real writing. My novels represented my real work, my best stuff written for honest-to-God readers. But I discovered that when I started working on a game novel for TOR Books' Crossroads series (called *Revolt on Majipoor,* and with every purchase I'll include . . .), I ended up caring about the crazy thing. Despite the goofy system of choices and dice rolling (which I don't mind in a solitaire role-playing module), I found myself writing characters and scenes that I believed in and cared about.

Largely, I suspect, because I had been genuinely touched by Robert Silverberg's Majipoor books, especially *Lord Valentine's Castle.*

I'd be less than honest if I didn't admit that the whole process surprised me.

Then I wondered . . . if F. Scott Fitzgerald were alive today, with crazy Zelda in tow and all, would he too, on the way to screenwriting and disillusion in Hollywood, not be above pumping out a game novel or two? And boy, wouldn't they be something to read! (If the Great Gatsby should return to East Egg, Long Island, turn to Section 29. If he orders another aperitif by the pool, turn to Section 81.)

So while I like my games as just games, and prefer my novels controlled by a caring, creative author instead of dice, I realize that there's room for other views. And, quite possibly, real writing in the format.

Ace Books, along with TOR, has recently licensed their own series of game novels. Like TOR, they are derived from the works of well-known authors. But unlike TOR, they focus on large-scale conflict with lots of game action. The series is called *Combat Command* and the first book, *Cut by Emerald,* shows some interesting variations in the usual game novel format.

The book was based on Piers Anthony's *Bio of a Space Tyrant* series and features an introduction by Anthony.

(continued on page 146)

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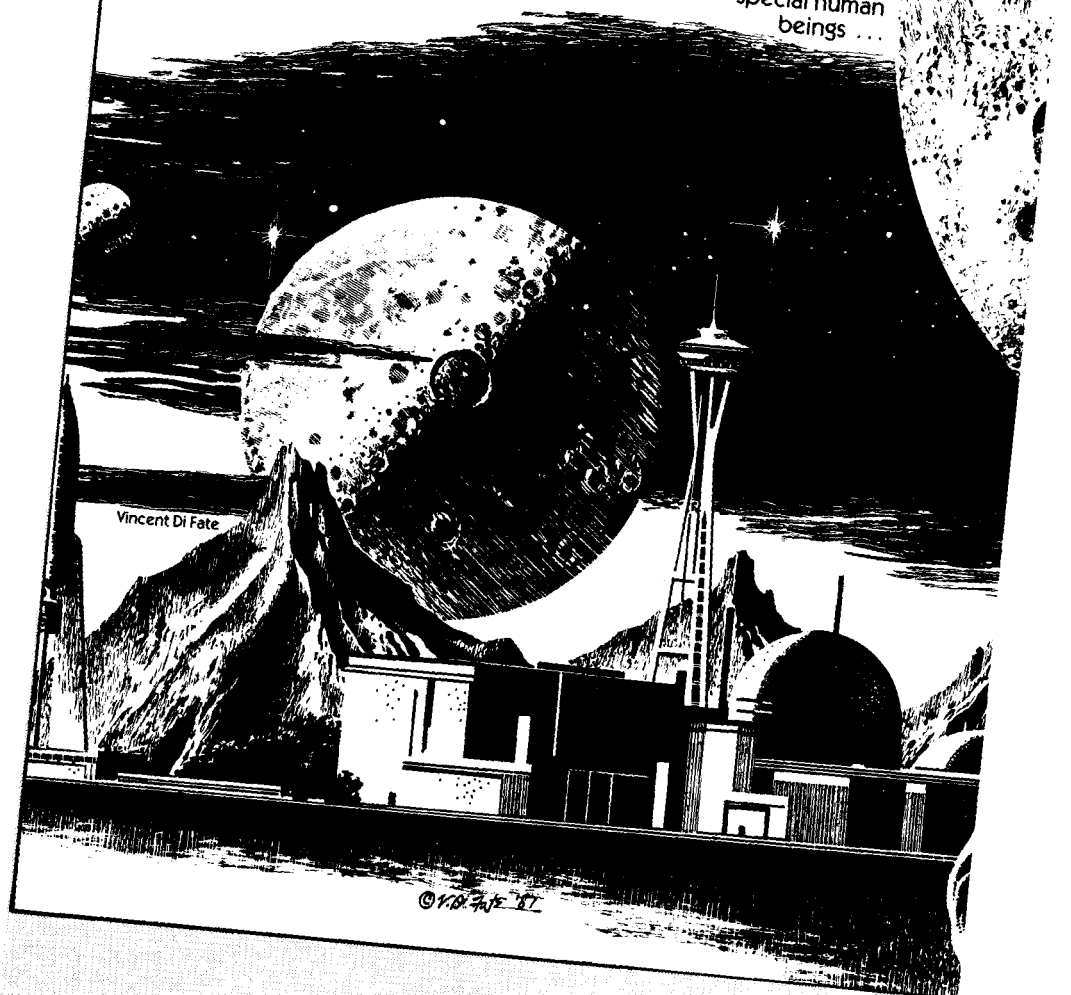
FALLING FREE

Lois McMaster Bujold

Part II of IV

It's not uncommon for an advance in one technology to make another obsolete. And when that one consists of special human beings . . .



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Engineer **LEO GRAF** *arrived at the Cay Habitat, a space R&D facility orbiting the planet Rodeo, expecting to teach his short course in advanced welding and non-destructive testing techniques to a class of space workers. But Leo nearly went into shock when his new boss, Chief of Project* **BRUCE VAN ATTA,** *introduced him to his first student,* **TONY**. *The workers were a genetically-engineered new species of human designed to live and work permanently in free fall. In addition to numerous metabolic changes, the most spectacular alteration was the replacement of useless downsider legs with a second set of arms.*

Tony in turn introduced Leo proudly to **CLAIRE**, *his quaddie girlfriend, and their infant son* **ANDY**. *"The workers," Van Atta explained, "are self-replicating," at least after the first generation who were bred in artificial wombs. Leo quickly came to like the four-armed quaddies, but remained uneasy, recognizing that GalacTech was reintroducing slavery in a high-tech guise.*

GalacTech psychologist **DR. SONDRA YEI** *did not relieve Leo's uneasiness by a strict lecture on how to behave so as not to corrupt the carefully-nurtured quaddies with contraband ideas. His struggle to articulate his unease only offended her. Yei's own main worry, based on her keen understanding of the quaddies' total lack of legal rights, was to socialize them so thoroughly that even those persons violently prejudiced against the products of bioengineering could not perceive them as a threat. She had no illusions about the negative outcome for the quaddies of such a confrontation. Quelling his doubts, Leo settled in and began his classes.*

Yet changes were already beginning, despite Yei's care. The careless behavior of Van Atta, above Yei's reach for discipline, was already giving the quaddies an array of ideas and techniques for alternative lifestyles not in the company specs—especially the pretty blonde **SILVER**, *whom Van Atta was using sexually.*

Six weeks after Leo's arrival, Tony and Claire's happy tranquillity was shattered. Due to a Habitat-wide drive by Van Atta to increase productivity, Claire was given her new "reproduction assignment" early—scheduled to start a new pregnancy. It didn't include Tony. Tony, rated tops in his class, was slated to depart on assignment to the first deep-space construction project GalacTech had landed for its new quaddie workers. Leo noticed Tony seemed depressed and distracted in class, but stopped short of prying the cause out of the boy.

Later, he wished he had. With the aid of their friend Silver, Tony and Claire planned to escape the Habitat.

Silver, extending lessons learned from her contact with Van Atta, had been trading sex with shuttle pilot **TI GULIK** *in exchange for contraband books and vids. (Silver's taste ran to titles like "Love in the Gazebo," not to be found in the strictly censored company library which was stocked with thrillers like "Cleaning and Maintenance Techniques For Food Service Areas.") For Ti their affair was a mere diversion while on his enforced gravity leaves from his primary occupation as a Jump-*

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ship pilot. But this time Silver found it an excellent way to distract the pilot while Tony, Claire, and Andy sneaked aboard his freight shuttle bound, they thought, for the orbital transfer station on the other side of the planet. From there they planned to stow away on an outbound Jumpship and escape from GalacTech.

Meanwhile, GalacTech Operations Vice President **APMAD** *arrived early on an inspection tour of the Rodeo mining and drilling facilities and especially of the Cay Habitat. Ti's shuttle was diverted downside to Rodeo Shuttleport Three, to pick up supplies urgently needed for the dog-and-pony show planned at the Habitat for Apmad's benefit. Crippled by gravity, the little refugee family fled the shuttle to hide in an automated freight warehouse at the shuttleport.*

Back at the Habitat, Leo and Yei began a frantic search for their pet students. Leo thought to question Silver first. He had almost convinced her to tell him Tony and Claire's whereabouts when Van Atta and Yei broke in on them. Van Atta's anger frightened Silver, and she clammed up. Van Atta, now utterly infuriated, hauled her off to be questioned under drugs.

CAPTAIN GEORGE BANNERJI, *Shuttleport Three's chief of Security, answered his vid to find Van Atta, clearly laboring under strong emotion: "We have a little problem here, Captain." Bannerji was new on Rodeo; Van Atta's urgent pleas for secrecy in the recapture of the "escaped experimental subjects" thoroughly alarmed the security man. Unnerved, he traded his lightweight Security stunner for an unregistered and lethal pistol. Feeling better, he shrugged his uniform jacket back on and turned to greet his patrolmen reporting for emergency duty.*

CHAPTER FIVE

Leo paused outside the airseal doors to the Habitat's infirmary to gather his nerve. He had been secretly relieved when a frantic call from Pramod had pulled him, shaking inside, away from the excruciating interrogation of Silver; as secretly ashamed of his relief. Pramod's problem—fluctuating power levels in his beam welder, traced at last to poisoning of the electron-emitting cathode by gas contamination—had occupied Leo for a time, but with the welding show over, shame had driven him back here.

So what are you going to do for her at this late hour? his conscience mocked him. *Assure her of your continued moral support, as long as it doesn't involve you in anything inconvenient or unpleasant? What a comfort.* He shook his head, tapped the door control.

Leo drifted silently past the medtech's station without signing in. Silver was in a private cubicle, a quarter-wedge of the infirmary's circumference at the very end of the module. The distance had helped muffle the yelling and crying.

Leo peered through the observation window. Silver was alone, floating limply in the locked sleep restraints against the wall. In the light from the fluoros her face was greenish, pale and damp. Her eyes seemed drained of their sparkling blue color, blurred leaden smudges. A yet-unused spacesick sack

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was clutched, hot and wrinkled, in an upper hand.

Sickened himself, Leo glanced up the corridor to be sure he was still unobserved, swallowed the clot of impotent rage growing in his throat, and slipped inside.

"Uh . . . hi, Silver," Leo began with a weak smile. "How you doing?" He cursed himself silently for the inanity of his own words.

Her smeary eyes found and focused on him uncomprehendingly. Then, "Oh. Leo. I think I was asleep for . . . for a while. Funny dreams . . . I still feel sick."

The drug must be wearing off. Her voice had lost the slurred, dreamy quality it had had during the interrogation earlier; now it was small and tight and self-aware. She added with a quaver of indignation, "That stuff made me throw up. And I've never thrown up before, not ever. It *made* me."

There were, Leo had learned, the most intense social inhibitions against vomiting in free fall, in Silver's little world. She would probably have been far less embarrassed at being stripped naked in public.

"It wasn't your fault," he hastened to reassure her.

She shook her head, her hair waving in lank strands unlike its usual bright aureole, her mouth pinched. "I should have—I thought I could . . . the Red Ninja never told *his* enemies his secrets, and they drugged and tortured him both!"

"Who?" asked Leo, startled.

"Oh . . . !" Silver's voice flattened to a wail. "They found out about our books, too! This time they'll find them all. . . ." Her lashes clotted with tears that could not fall, but only accumulate until blotted away. When her eyes widened to stare at Leo in a horrified realization, two or three droplets flew off in shimmering tangents. "And now Mr. Van Atta thinks Ti must have known Tony and Claire were on his shuttle —collusion—he says he's going to get Ti fired! And he'll find Tony and Claire down there—I don't know what he'll do to them. I've never seen Mr. Van Atta so angry."

Leo's set jaw had ground his smile to a grimace. Still he tried to speak reasonably. "But you told them—under drugs—that Ti didn't know, surely."

"He didn't believe it. Said I was lying."

"But that would be logically inconsistent—" Leo began, cut himself short. "No, you're right, that wouldn't faze him. God, what an asshole."

Silver's mouth opened in shock. "You mean—Mr. Van Atta?"

"I mean Brucie-baby. You can't tell me you've been around the man for what, eleven months, and not figured that out."

"I thought it was me—something wrong with me . . ." Silver's voice was still small and teary, but her eyes began to brighten with a sort of pre-dawn light. She overcame her inner miseries enough to regard Leo with increased attention. ". . . Brucie-baby?"

"Huh." The memory of one of Dr. Yei's lectures about *maintaining unified and consistent authority* gave Leo pause. It had seemed to make great sense at the time. . . . "Never mind. But there's nothing wrong with you, Silver."

Her regard was sharpening to some-

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thing almost scientific. "You're not afraid of him." Her tone of wonder suggested she found this an unexpected and remarkable discovery.

"Me? Afraid of Bruce Van Atta?" Leo snorted. "Not likely."

"When he first came, and took over Dr. Cay's position, I thought—thought he would be like Dr. Cay."

"Look, ah . . . there is a very ancient rule of thumb that states, people tend to get promoted to the level of their incompetence. So far I think I've managed to avoid that unenviable plateau. So, I gather, did your Dr. Cay." *Screw Yei's scruples*, Leo thought, and added bluntly, "Van Atta hasn't."

"Tony and Claire would never have tried to run away if Dr. Cay were still here." A straggling species of hope began in her eyes. "Are you saying you think this mess could be Mr. Van Atta's fault?"

Leo stirred uneasily, pronged by secret convictions he had not yet voiced even to himself. "Your s—, s—," *slavery* "situation seems intrinsically, intrinsically," *wrong* his mind supplied, while his mouth fishtailed, "susceptible to abuse, mishandling of all sorts. Because Dr. Cay was so passionately dedicated to your welfare—"

"Like a father to us," Silver confirmed sadly.

"—this, er, susceptibility remained latent. But sooner or later it's inevitable that someone begin to exploit it, and you. If not Van Atta, someone else down the line. Someone . . ." *worse?* Leo had read enough history. Yes. "Much worse."

Silver looked as if she were struggling to imagine something worse than Van Atta, and failing. She shook her head dolefully. She raised her face to Leo; eyes like morning glories, targeting the sun. The target, struck, jerked out an involuntary smile.

"What's going to happen now, to Tony and Claire? I tried not to give them away, but that stuff made me so woozy—it was dangerous for them before, and now it's worse. . . ."

Leo attempted a tone of bluff and hearty reassurance. "Nothing's going to happen to them, Silver. Don't let Bruce's snit spook you. There's not really much he can do to them, they're much too valuable to GalacTech. He'll yell at them, no doubt, and you can't blame him for that; I'm ready to yell at them myself. Security will pick them up downside—they can't have gone far—they'll get the lecture of their young lives, and in a few weeks it'll all blow over. Lessons learned," Leo faltered. Just what lessons would they learn from this fiasco? "—all around."

"You act like—like getting yelled at—was nothing."

"It comes with age," he offered. "Someday you'll feel that way too." Or was it power that this particular immunity came with? Leo was suddenly unsure. But he had no power to speak of, except the ability to build things. Knowledge as power. Yet who had power over him? The line of logic trailed off in confusion; he turned his thoughts impatiently from it. Mental wheel-spinning, as unproductive as philosophy class in college.

"I don't feel that way now," said Silver practically.

"Look, uh . . . tell you what. If it'll make you feel better, I'll go along

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downside when they locate those kids. Maybe I can kind of keep things under control."

"Oh, would you? Could you?" Silver asked with relief. "Like you were trying to help me?"

Leo felt like biting his tongue off. "Uh, yeah. Something like that."

"You're not afraid of Mr. Van Atta. You can stand up to him." Her eyebrows quirked self-deprecatingly, and she waved her lower arms. "As you can see, I'm not equipped to stand up to anybody. Thank you, Leo." There was even a little color in her face now.

"Uh, right. I better hustle along now, if I'm to catch the shuttle going down to 'Port Three. We'll have 'em back safe and sound by breakfast. Think of it this way, at least GalacTech can't dock their pay for the extra shuttle trip." This even won a brief smile from her.

"Leo . . . " her voice sobered, and he paused on his way out the door. "What are we going to do if . . . if there's ever anyone worse than Mr. Van Atta?"

Cross that bridge when you come to it, he wanted to say, evading the question. But one more platitude and he'd gag. He smiled and shook his head, and fled.

The warehouse made Claire think of a crystal lattice. It was all right angles, stretching away at ninety degrees in each dimension, huge slotted shelves reaching to the ceilings, endless rows, cross corridors. Blocking vision, blocking flight.

But there was no flight here. She felt like a stray molecule caught in the interstices of a doped crystal wafer, out of place but trapped. In retrospect the cozy curves of the Habitat seemed like enclosing arms.

They huddled now in one empty cell of a shelf stack, one of the few they had not found occupied by supplies, measuring some two meters on a side. Tony had insisted on climbing to the third tier, to be above the eye level of any chance downsider walking along the corridor upright on his long legs. The ladders set at intervals along the shelves had actually proved easier to manage than creeping along the floor, but getting the pack up had been a dreadful struggle, as its cord was too short to climb up and draw it up after themselves.

Claire was secretly unnerved. Andy was already finding an ability to push and grunt and wriggle against the gravity, still only a few centimeters at a time, but she had a nasty vision of him falling over the edge. Claire was developing a distaste for edges.

A robotic forklift whirred past. Claire froze, cowering in the back of their recess, clutching Andy to her, grabbing one of Tony's hands. The whirring trailed off into the distance. She breathed again.

"Relax," Tony squeaked. "Relax . . ." He breathed deeply in an apparent effort to follow his own advice.

Claire peered doubtfully out of the cubicle at the forklift, which had stopped farther down the corridor and was engaged in retrieving a plastic carton from its coded cell.

"Can we eat now?" She had been nursing Andy on and off for the last three hours in an effort to keep him quiet, and was drained in every sense.

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Her stomach growled, and her throat was dry.

"I guess," said Tony, and dug a couple of ration bars out of their hoard in the pack. "And then we'd better try and work our way back to the hangar."

"Can't we rest here a little longer?"

Tony shook his head. "The longer we wait, the more of a chance they'll be looking for us. If we don't get on a shuttle for the Transfer Station soon, they may start searching the outbound Jump ships, and there goes our chance of stowing away undiscovered until after they boost past the point of no return."

Andy squeaked and gurgled; a familiar aroma wafted from his vicinity.

"Oh, dear. Would you please get out a diaper?" Claire asked Tony.

"Again? That's the fourth time since we left the Habitat."

"I don't think I brought near enough diapers," Claire worried, smoothing out the laminated paper and plastic form Tony handed her.

"Half our pack is filled with diapers. Can't you—make it last a little longer?"

"I'm afraid he may be getting diarrhea. If you leave that stuff on his bottom too long, it eats right through his skin—gets all red—even bleeds—gets infected—and then he screams and cries every time you touch it to try and clean it. Real loud," she emphasized.

The fingers of Tony's lower right hand drummed on the shelf floor, and he sighed, biting back frustration. Claire wrapped the used diaper tightly in itself and prepared to stash it back in their pack.

"Do we have to cart those along?" Tony asked suddenly. "Everything in the pack is going to reek after a while. Besides, it's heavy enough already."

"I haven't seen a disposal unit anywhere," said Claire. "What else can we do with them?"

Tony's face screwed up with inner struggle. "Just leave it," he blurted. "On the floor. It's not like it's going to float off down the corridor and get into the air recirculation, here. Leave them all."

Claire gasped at this horrific, revolutionary idea. Tony, following up his own suggestion before his nerve failed, collected the four little wads and stuffed them into the far corner of the storage cubicle. He smiled shakily, in mixed guilt and elation. Claire eyed him worriedly. Yes, the situation was extraordinary, but what if Tony was developing a habit of criminal behavior? Would he return to normal when they got —wherever they were going?

If they got wherever they were going. Claire pictured their pursuers following the dirty diapers, like a trail of flower petals dropped by that heroine in one of Silver's books, across half the galaxy. . . .

"If you've got him back together," said Tony with a nod at his son, "maybe we better start back toward the hangar. That mob of downsiders may be cleared out by now."

"How are we going to pick a shuttle this time?" asked Claire. "How will we know that it's not just going right back up to the Habitat—or taking up a cargo to be unloaded in the vacuum? If they vent the cargo bay into space while we're in it . . ."

Tony shook his head, lips tight. "I don't know. But Leo says—to solve a

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big problem, or complete a big project, the secret is to break it down into little parts and tackle them one at a time, in order. Let's—just get back to the hangar, first. And see if there's any shuttles there at all."

Claire nodded, paused. Andy was not the only one of them plagued by biology, she reflected grimly. "Tony, do you think we can find a toilet on the way back? I need to go."

"Yeah, me too," Tony admitted. "Did you see any on the way here?"

"No." Locating the facilities had not been uppermost on her mind then, on that nightmare journey, creeping over the floors, dodging hurrying downsiders, squeezing Andy tightly to her for fear that he might cry out. Claire wasn't even sure she could reconstruct the route they'd taken, when they'd been driven out of their first hiding place by the busy work crew descending upon their machines and powering them up.

"There's got to be something," Tony reasoned optimistically, "people work here."

"Not in this section," Claire noted, gazing out at the wall of storage cells across the aisle. "It's all robots."

"Back toward the hangar, then. Say . . ." his voice faltered, "uh . . . do you happen to know what a gravity-field toilet chamber looks like? How do they manage? Air suction couldn't possibly fight the *gee* forces."

One of Silver's smuggled historical vid dramas had involved a scene with an outhouse, but Claire was certain that was obsolete technology. "I think they use water, somehow."

Tony wrinkled his nose, shrugged away his bafflement. "We'll figure it out." His eye fell rather wistfully on the little wad of diapers in the corner. "It's too bad . . ."

"No!" said Claire, repelled. "Or at least—at least let's *try* to find a toilet first."

"All right."

A distant rhythmic tapping was growing louder. Tony, about to swing out on the ladder, muttered "Oops," and recoiled back into the cubicle. He held a finger to his lips, panic in his face, and they all scuttled to the back of the cell.

"Aaah?" said Andy. Claire snatched him up and stuffed the tip of one breast into his mouth. Full and bored, he declined to nurse, turning his head away. Claire let her T-shirt fall back down and tried to distract him by silently counting all his busy fingers. He too had become smudged with dirt, as she had; no big surprise, planets were *made* of dirt. Dirt looked better from a distance. Say, a couple of hundred kilometers . . .

The tapping grew louder, passed under their cell, faded.

"Company Security man," Tony whispered in Claire's ear.

She nodded, hardly daring to breathe. The tapping was from those hard downsider footcoverings striking the cement floor. A few minutes passed, and the tapping did not return. Andy made only small cooing noises.

Tony stuck his head cautiously out the chamber, looked right and left, up and down. "All right. Get ready to help me lower the pack as soon as this next forklift goes by. It'll have to fall the last meter, but maybe the sound of the forklift will cover that some."

Together they shoved the pack toward the edge of the cell, and waited. The

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whirring robolift was approaching down the corridor, an enormous plastic storage crate almost as large as a cubicle positioned on its lift.

The forklift stopped below them, beeped to itself, and turned ninety degrees. With a whine, its lift began to rise.

At this point, Claire recalled that theirs was the only empty cell in this stack.

"It's coming *here!* We're going to get squashed!"

"Get out! Get out on the ladder!" Tony yelped.

Instead she scuttled back to grab Andy, whom she'd laid at the rear of the chamber as far as possible from the frightening edge while she'd helped Tony shove the pack forward. The chamber darkened as the rising crate eclipsed the opening. Tony barely squeezed past it onto the ladder as it began to grind inward.

"Claire!" Tony screamed. He pounded uselessly on the side of the huge plastic crate. "Claire! No, no! Stupid robot! Stop, stop!"

But the forklift, clearly, was not voice-activated. It kept coming, bulldozing their pack before it. There were only a few centimeters clearance on the sides and top of the crate. Claire retreated, so terrified her screams clotted in her throat like cotton, and she emitted only a smeary squeak. Back, back; the cold metal wall behind froze her. She flattened against it as best she could, standing on her lower hands, holding Andy with her uppers. He was howling now, infected by her terror, earsplitting shrieks.

"Claire!" Tony cried from the ladder, a horrified bellow laced with tears. "ANDY!"

The pack, beside them, compressed. Little crunching noises came from it. At the last moment, Claire transferred Andy to her lower arms, below her torso, bracing against the crate, against gravity, with her uppers. Perhaps her crushed body would hold the crate off just far enough to save him—the robolift's servos skreeled with overload . . .

And began to withdraw. Claire sent a silent apology to their oversized pack for all the curses she and Tony had heaped upon it in the past hours. Nothing in it would ever be the same, but it had saved them.

The robolift hiccoughed, gears grinding bewilderedly. The crate shifted on its pallet, out of sync now. As the lift withdrew, the crate skidded with it, dragged by friction and gravity, skewing farther and farther from true.

Claire watched open-mouthed as it tilted and fell from the opening. She rushed forward. The crash shook the warehouse as the crate hit the concrete, followed by a booming shattered echo, the loudest sound Claire had ever heard. The crate took the forklift with it, its wheels whirring helplessly in air as it banged onto its side.

The power of gravity was stunning. The crate split, its contents spilling. Hundreds of round metal wheelcovers of some kind burst forth, ringing like a stampede of cymbals. A dozen or so rolled down the aisle in either direction as if bent on escape, wobbling into the corridor walls and falling onto their sides, still spinning, in ever-diminishing wanging pulses of sound. The echoes

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rang on in Claire's ears for a moment in the stupendous silence that followed.

"Oh, Claire!" Tony swarmed back into the cell and wrapped all his arms around her, Andy between them, as if he might never let go again. "Oh, Claire . . ." his voice cracked as he rubbed his face against her soft short hair.

Claire looked over his shoulder at the carnage they had created, below. The overturned robolift was beeping again, like an animal in pain. "Tony, I think we better get out of here," she suggested in a small voice.

"I thought you were coming behind me, onto the ladder. Right behind me."

"I had to get Andy."

"Of course. You saved him, while I—saved myself. Oh, Claire! I didn't mean to leave you in there . . ."

"I didn't think you did."

"But I jumped—"

"It would have been plain stupid not to. Look, can we talk about it *later?* I *really* think we ought to get out of here."

"Yes, oh yes. Uh, the pack . . . ?" Tony peered into the dimness of the recess.

Claire didn't think they were going to have time for the pack, either—yet how far could they get without it? She helped Tony drag it back to the edge with frantic haste.

"If you brace yourself back there, while I hang onto the ladder, we can lower it—" Tony began.

Claire pushed it ruthlessly over the edge. It landed on the mess below, tumbled to the concrete. "I don't think there's any more point in worrying about the breakables now. Let's *go*," she urged.

Tony gulped, nodded, moved quickly onto the ladder, sparing one upper arm to help support Andy, whom Claire held in her lowers, her upper hands slapping down the rungs. Then they were back to the floor and their slow, frustrating, crabwise locomotion along it. Claire was beginning to hate the cold, dusty smell of concrete.

They were only a few meters down the corridor when Claire heard the pounding of downsider footcoverings again, moving fast, with uncertain pauses as if for direction. A row or two over; the steps must shortly thread the lattice to them. Then an echo of the steps—no, another set.

What happened next seemed all in a moment, suspended between one breath and the next. Ahead of them, a grey-uniformed downsider leaped from a cross-corridor into their own with an unintelligible shout. His legs were braced apart to support his half-crouch, and he clutched a strange piece of equipment in both hands, held up half a meter in front of his face. His face was as white with terror as Claire's own.

Ahead of her, Tony dropped the pack and reared up on his lower arms, his upper hands flung wide, crying, "No!"

The downsider recoiled spasmodically, his eyes wide, mouth gaping in shock. Two or three bright flashes burst from his piece of equipment, accompanied by sharp cracking bangs that echoed, splintered, all through the great warehouse. Then the downsider's hands jerked up, the object flung away. Had it malfunctioned or short-circuited,

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burning or shocking him? His face drained further, from white to green.

Then Tony was screaming, flopping on the floor, all his arms curling in on himself in a tight ball of agony.

"Tony? Tony!" Claire scrambled toward him, Andy clamped tightly to her torso and crying and screaming in fear, his racket mingling with Tony's in a terrifying cacaphony. "Tony, what's wrong?" She didn't see the blood on his red T-shirt until some drops spattered on the concrete. The bicep of his left lower arm, as he rolled toward her, was a scrambled, pulsing, scarlet and purple mess. "Tony!"

The company security guard had rushed forward. His face was harrowed with horror, his hands empty now and fumbling with a portable comm link hooked to his belt. It took him three tries to detach it. "Nelson! Nelson!" he called into it. "Nelson, for God's sake call the medical squad, quick! It's just *kids!* I just shot a *kid!*" His voice shook. "It's just some crippled *kids!*"

Leo's stomach sank at the sight of the yellow pulses of light reflecting off the warehouse wall. Company medical squad; yes, there was their electric truck, blinkers flashing, parked in the wide central aisle. The breathless words of the clerk who'd met their shuttle tumbled through his brain— . . . *found in the warehouse . . . there's been an accident . . . injury . . .* Leo's steps quickened.

"Slow down Leo, I'm getting dizzy," Van Atta, behind him, complained irritably. "Not everybody can bounce back and forth between null-*gee* and one-*gee* like you do with no effects, you know."

"They said one of the kids was hurt. . . ."

"So what are you going to do that the medics can't? I, personally, am going to crucify that idiot Security team for this. . . ."

"I'll meet you there," Leo snarled over his shoulder, and ran.

Aisle 29 looked like a war zone. Smashed equipment, stuff scattered everywhere—Leo half-tripped over a couple of round metal cover plates, kicked them impatiently out of his way. A pair of medics and a Security guard were huddled over a stretcher on the floor, an IV bag hoisted on a pole like a flag above them.

Red shirt; Tony, it was Tony who'd been hurt. Claire was crouched on the floor a little farther down the aisle, clutching Andy, tears streaming silently down her ragged white mask of a face. On the stretcher, Tony writhed and cried out with a hoarse sob.

"Can't you at least give him something for the pain?" the security guard urged the medtech.

"I don't *know*." The medtech was clearly flustered. "I don't know what they've done to their metabolisms. Shock is shock, I'm safe with the IV and the warmers and the synergine, but as for the rest of it—"

"Patch in an emergency comm link to Dr. Warren Minchenko," Leo advised, kneeling beside them. "He's chief medical officer for the Cay Habitat, and he's on his month's downside leave right now. Ask him to meet you at your infirmary, he'll take over the case there."

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The Security guard eagerly unhooked his comm link and began punching in codes.

"Oh, thank God," said the medtech, turning to Leo. "At last, somebody who knows what the hell they're doing. Do you know what I can give him for pain, sir?"

"Uh . . ." Leo did a quick mental review of his first aid. "Syntha-morph should be all right, until you get in touch with Dr. Minchenko. But adjust the dose—these kids weigh less than they look like they ought to—I think Tony masses about, um, 42 kilos."

The peculiar nature of Tony's injuries dawned on Leo at last. He had been picturing a fall, broken bones, maybe spinal cord or cranial damage. . . . "*What happened here?*"

"Gunshot wound," reported the medtech shortly. "Left lower abdomen and . . . and, um, not femur—left lower limb. That's just a flesh wound, but the abdominal one is serious."

"Gunshot!" Leo stared aghast at the guard, who reddened. "Did you—I thought you guys carried stunners—why in the name of God—"

"When that damned hysteric called down from the Habitat, yammering about his escaped monsters, I thought—I thought—I don't know what I thought." The guard glowered at his boots.

"Didn't you look before you fired?"

"I *damn* near shot the girl with the baby." The guard shuddered. "I hit this kid by accident, jerking my aim away."

Van Atta panted up. "Holy shit, what a mess!" His eye fell on the security guard. "I thought I told you to keep this quiet, Bannerji. What did you do, set off a bomb?"

"He shot Tony," said Leo through his teeth.

"You idiot, I told you to capture them, not murder them! How the hell am I supposed to sweep *this*—" he waved his arm down Aisle 29, "under the rug? And what the hell were you doing with a pistol anyway?"

"You said—I thought—" the guard began.

"I swear I'll have you canned for this. Of all the ass-backwards—did you think this was some kind of feelie-dream drama? I don't know whose judgement is worse, yours or the jerk's who hired you—"

The guard's face had gone from red to white. "Why you stupid son-of-a-bitch, you set me up for this—"

Somebody had better keep a level head, Leo thought wretchedly. Bannerji had retrieved and holstered his unauthorized weapon, a fact Van Atta seemed to be unconscious of—the temptation to shoot the Project chief shouldn't be allowed to get too overwhelming—Leo intervened. "Gentlemen, may I suggest that charges and defenses would be better saved for a formal investigation, where everyone will be cooler and, er, more reasoned. Meantime we have some hurt and frightened kids to take care of."

Bannerji fell silent, simmering with injustice. Van Atta growled assent, contenting himself with a black look toward Bannerji that boded ill for the guard's future career. The two medtechs snapped down the wheels of Tony's stretcher and began rolling him down the aisle toward their waiting truck. One of Claire's hands reached out after him, fell back hopelessly.

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The gesture caught Van Atta's attention. Full of suppressed rage, he discovered he had an object on which to vent it after all. "You—!" he turned on Claire.

She flinched into a tighter huddle.

"Do you have any idea what this escapade of yours is going to cost the Cay Project, first to last? Of all the irresponsible—did you con Tony into this?"

She shook her head, eyes widening.

"Of course you did, isn't it always the way. The male sticks his neck out, the female gets it chopped off for him. . . ."

"Oh, no . . ."

"And the timing—were you deliberately trying to smear me? How did you find out about the Ops VP—did you figure I'd cover up for you just because she was here? Clever, clever—but not clever enough . . ."

Leo's head, eyes, ears throbbed with the beating of his blood. "Lay off, Bruce. She's had enough for one day."

"The little bitch nearly gets your best student killed, and you want to stand up for her? Get serious, Leo."

"She's already scared out of her wits. Lay off."

"She damn well better be. When I get her back to the Habitat . . ." Van Atta strode past Leo, grabbed Claire by an upper arm, yanked her cruelly and painfully up. She cried out, nearly dropping Andy; Van Atta overrode her. "You wanted to come downside, you can bloody well just *try* walking—back to the shuttle, then."

Leo could not, afterwards, recall running forward or swinging Van Atta around to face him, but only Van Atta's surprised, open-mouthed expression. "Bruce," he sang through a red haze, "you smarmy creep—lay *off!*"

The uppercut to Van Atta's jaw that punctuated this command was surprisingly effective, considering it was the first time Leo had struck a man in anger in his life. Van Atta sprawled backwards on the concrete.

Leo surged forward in a kind of dizzy joy. He would rearrange Van Atta's anatomy in ways that even Dr. Cay had never dreamed of—

"Uh, Mr. Graf," the security guard began, touching him hesitantly on the shoulder.

"It's all right, I've been wanting to do this for weeks," Leo assured him, going for a grip on Van Atta's collar.

"It's not that, sir . . ."

A cold new voice cut in. "Fascinating executive technique. I must take notes."

Vice President Apmad, flanked by her flying wedge of accountants and assistants, stood behind Leo in Aisle 29.

CHAPTER SIX

"Well, it wasn't *my* fault," snapped Shuttleport Administrator Chalopin. "I wasn't even told this was going on." She glowered pointedly at Van Atta. "How am I supposed to control my jurisdiction when *other* administrators hopscotch my properly established channels of command, blithely hand out orders to my people without even informing me, violate protocol—"

"The situation was extraordinary. Time was of the essence," muttered Van Atta truculently.

Leo secretly sympathized with Chalopin's testiness. Her smooth routine disrupted, her office abruptly appropriated for the Ops VP's inquest—Apmad

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did not believe in wasting time. The official company investigation of the incident had commenced, by her fiat, a bare hour ago in Aisle 29; he'd be surprised if it took her more than another hour to finish sifting through the case.

The windows of Shuttleport Three's administrative offices, sealed against the internal pressure of the building, framed a panorama of the complex—the runways, loading zones, warehouses, offices, hangars, workers' dormitories, the monorail running off to the refinery glittering on the horizon and the eerily rugged mountains beyond. And the vital power plant; Rodeo's atmosphere had oxygen, nitrogen, and carbon dioxide, but in the wrong proportions and at too low a pressure to suit human metabolism. The air conditioning labored constantly to adjust the gas mix and filter out the contaminants. A human might live for fifteen minutes outside without a breath mask; Leo was uncertain whether to think of it as a safety margin or just a slow death. Definitely not a garden spot.

Bannerji had sidled around behind the shuttleport administrator. Hiding behind her, Leo thought. It might be the best strategy for the security guard at that. From her smart shoes to her trim GalacTech uniform, to her swept-back coiffure—not a hair out of place—and her set, clean jawline, Chalopin radiated both the will and the ability to defend her turf.

Apmad, refereeing the scrimmage, was another type altogether. Dumpy, on the high end of middle age, frizzy grey hair cut short, she might have been somebody's grandmother, but for her eyes. She made no attempt to dress for success. As if she already possessed so much power, she was beyond that game. So far from regulating tempers, her laconic comments had served to stir the pot, as if she was curious what might float to the top. Definitely not a grandmother's eyes . . .

Leo was still close to a boil himself. "The project is twenty-five years old. Time can't be that much of the essence."

"God almighty," cried Van Atta, "Am I the only man here conscious of what the bottom line means?"

"Bottom line?" said Leo. "GalacTech is closer to its payoff from the Cay Project than ever before. To screw things up now with an impatient, premature attempt to wring profits is, is practically criminal. You're on the verge of the first real results."

"Not really," observed Apmad coolly. "Your first group of fifty workers is merely a token. It will take another ten years to bring the whole thousand online." Cool, yes; but Leo read a fierce concealed tension in her the source of which he could not yet identify.

"So, call it a tax loss. You can't tell me this," Leo waved a hand toward the window, indicating Rodeo, "can't use a tax loss or two."

Apmad rolled her eyes at the man who stood silently at her shoulder. "Tell this young man the facts of life, Gavin."

Gavin was a big rumpled goon with a broken nose whom Leo had taken at first for some kind of bodyguard. He was in fact the Ops VP's chief accountant, and when he spoke it was with startlingly precise and elegant elocution, in impressive rounded paragraphs.

"GalacTech has been offsetting the

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Cay Project's very considerable losses with Rodeo's paper profits since its inception. I'd better recapitulate a little history for you, Mr. Graf." Gavin scratched his nose thoughtfully.

"GalacTech holds Rodeo from the government of Orient IV on a ninety-nine year lease. The original terms of the lease were extremely favorable to us, since Rodeo's unique mineral and petrochemical resources were at that time still undiscovered. And so they remained for the first thirty years of the lease.

"The next thirty years saw an enormous investment of materials and labor on the part of GalacTech to develop Rodeo's resources. Of course," he prodded the air with a didactic finger, "as soon as Orient IV began to see our profit passing through their wormhole nexus, they began to regret the terms of the lease, and to seek a larger cut of the action. Rodeo was chosen as the site for the Cay Project in the first place in part, besides certain unique legal advantages, precisely so that its projected expenses could be charged against Rodeo's profits generally, and reduce the, er, unhealthy excitement said profits were generating on Orient IV.

"GalacTech's lease of Rodeo now has some fourteen years left to run, and the government of Orient IV is getting, ah, how shall I put this, infected with anticipatory greed. They've just changed their tax laws, and from the end of this fiscal year they propose to tax the company's Rodeo operation upon gross, not net, profit. We lobbied against it, but we failed. Damn provincials," he added reflectively.

"So. After the end of this fiscal year, the Cay Project losses can no longer be offset against Orient IV tax savings; they will be real, and passed through to us. The terms of the new lease at the end of the next fourteen years are not expected to be favorable. In fact, we project Orient IV is preparing to drive GalacTech out and take over its Rodeo operations at a fraction of their real worth. Expropriation by any other name doth smell the same. The economic blockade is already beginning. The time to start limiting further investment and maximizing profit is now."

"In other words," said Apmad, a hard angry glitter in her eyes, "let them take over a hollow shell."

Could be hard on the last guys out, Leo thought, chilled. Didn't those jerks on Orient IV realize that cooperation and compromise would increase everybody's profit, in the end? The GalacTech negotiators were probably not without fault, either, he reflected grimly. He'd seen other versions of the hostile takeover scenario before. He glanced out the window at the large, lively, *working* facilities laid out below, hard-won results of two generations of sincere labor, and groaned inwardly at the thought of the waste to come. From the horrified look on Chalopin's face, she had a similar vision, and Leo's heart went out to her. How much of her blood had gone into the building-up of this place? How many people's sweat and dedication, cancelled at the stroke of a pen?

"That was always your problem, Leo," said Van Atta rather venomously. "You'd always get your head balled up in the little details, and miss the big picture."

Leo shook his head to clear it, grasped

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for the lost thread of his original argument. "Nevertheless, the Cay Project's viability—" he paused abruptly, seized by a breathtaking inspiration as delicate as a soap bubble. The stroke of a pen. Could freedom be won with the stroke of a pen? As simply as that? He gazed at Apmad with a new intensity, two orders of magnitude more at least. "Tell me, ma'am," he said carefully, "what happens if the Cay Project's viability is *dis*proved?"

"We shut it down," she said simply.

Oh, the tales out of school he might tell—and sink Brucie-baby forever as an added bonus—Leo's nerves thrilled. He opened his mouth to pour out destruction—

And closed it, sucked on his tongue, regarded his fingernails, and asked instead casually, "And what happens to the quaddies then?"

The Ops VP frowned as if she'd bitten into something nasty, that hidden tension again, the most expression Leo had yet seen upon her face. "That presents the most difficult problem of all."

"Difficult? Why difficult? Just let them go. In fact," Leo strove to conceal his rising excitement behind a bland face, "if GalacTech would let them go immediately, before the end of this fiscal year, it could still take whatever it chooses to calculate as its investment in them as a tax loss against Rodeo's profits. One last fling, as it were, one last bite out of Orient IV." Leo smiled attractively.

"Let them go where? You seem to forget, Mr. Graf, that the bulk of them are still mere children."

Leo faltered. "The older ones could help take care of the younger ones, they already do, some . . . Perhaps they could be moved for a few years to some other sector that could absorb the loss from their upkeep—it couldn't cost GalacTech *that* much more than a like number of workers on pensions, and only for a few years. . . ."

"The company retirement pension fund is self-supporting," Gavin the accountant observed elliptically. "Rollover."

"A moral obligation," Leo offered desperately. "Surely GalacTech must admit some moral obligation to them—we created them, after all." The ground was shifting under his feet, he could see it in her unsympathetic face, but he could not yet discern in what direction the tilt was going.

"Moral obligation indeed," agreed Apmad, her hands clenching. "And have you overlooked the fact that Dr. Cay created these creatures fertile? They are a new species, you know, he dubbed them *Homo quadrimanus*, not *Homo sapiens* race *quadrimanus*. He was the geneticist, we may presume he knew what he was talking about. What about GalacTech's moral obligation to society at large? How do you imagine it will react to having these creatures and all their problems just dumped into its systems? If you think they overreact to chemical pollution, just imagine the flap over genetic pollution!"

"Genetic pollution?" Leo muttered, trying to attach some rational meaning to the term. It *sounded* impressive.

"No. If the Cay Project is proved to be GalacTech's most expensive mistake, we will containerize it properly. The Cay workers will be sterilized and placed in some suitable institution, there

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to live out their lives otherwise unmolested. Not an ideal solution, but the best available compromise."

"St—st . . ." Leo stuttered. "What crime have they committed, to be sentenced to life in prison? And where, if Rodeo is to be closed down, will you find or build another suitable orbital habitat? If you're worried about expense, lady, *that'll* be expensive."

"They will be placed planetside, of course, at a fraction of the cost."

A vision of Silver creeping uncomfortably across the floor like a bird with both wings broken burst in Leo's brain. "That's *obscene!* They'll be no better than cripples."

"The obscenity," snapped Apmad, "was in creating them in the first place. Until Dr. Cay's death brought his department under mine, I had no idea that his 'R&D—Biologicals' was concealing such enormously invasive manipulations of human genes. My home world embraced the most painfully draconian measures to ensure our gene pool not be overrun with accidental mutations—to go out and deliberately introduce mutations seems the most vile . . ." she caught her breath, contained her emotions again, except what escaped her nervously drumming fingers. "The *right* thing to do is euthanasia. Terrible as it seems at first glance, it might actually be less cruel in the long run."

Gavin the accountant, squirming, twitched an uncertain smile at his boss. His eyebrows had gone up in surprise, down in dismay, and at last settled on up again—not taking her seriously, perhaps. Leo didn't think she'd been joking, but Gavin added in a facetiously detached professional tone, "It *would* be more cost-effective. If it were done before the end of this fiscal year, we could indeed take them as a loss —total—against Orient taxes."

Leo felt suspended in glass. "You can't do that!" he whispered. "They're people—children—it would be murder—"

"No, it would not," denied Apmad. "Repugnant, certainly, but not murder. That was the other half of the reason for locating the Cay Project in orbit around Rodeo. Besides physical isolation, Rodeo exists in legal isolation. It's in the ninety-nine year lease. The only legal writ in Rodeo local space is GalacTech regulation. I fear this had less to do with foresight than with Dr. Cay's successful blocking of any interference with his schemes. But if GalacTech chooses not to define the Cay workers as human beings, company regulations regarding crimes do not apply."

"Oh, really?" Bannerji brightened slightly.

"How *does* GalacTech define them?" asked Leo, glassily curious. "Legally."

"Post-fetal experimental tissue cultures," said Apmad.

"And what do you call murdering them? Retroactive abortion?"

Apmad's nostrils grew pinched. "Simple disposal."

"Or," Gavin glanced sardonically at Bannerji, "vandalism, perhaps. Our one legal requirement is that experimental tissue be cremated upon disposal. IGS Standard Biolab rules."

"Launch them into the sun," Leo suggested tightly. "That'd be cheap."

Van Atta stroked his chin gently and regarded Leo uneasily. "Calm down, Leo. We're just talking contingency

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scenarios here. Military staffs do it all the time."

"Quite," agreed the Ops VP. She paused to frown at Gavin, whose flippancy apparently did not please her. "There are some hard decisions to be made here, which I am not anxious to face, but it seems they have been dealt to me. Better me than someone blind to the long-term consequences to society at large like Dr. Cay. But perhaps, Mr. Graf, you will wish to join Mr. Van Atta in showing how Dr. Cay's original vision might still be carried out at a profit, so we can *all* avoid having to make the hardest choices."

Van Atta smiled at Leo, smarmily triumphant. Vindicated, vindictive, calculating . . . "To return to the matter at hand," Van Atta said, "I've already requested that Captain Bannerji be summarily terminated, for his poor judgment and," he glanced at Gavin, "and vandalism. I might also suggest that the cost of TY-776-424-X-G's hospitalization be charged to his department." Bannerji wilted, Administrator Chalopin stiffened.

"But it's increasingly apparent to me," Van Atta went on, fixing his most unpleasant smile on Leo, "that there's another matter to be pursued here. . . ."

Ah shit, thought Leo, he's going to get me on an assault charge—an eighteen year career up in smoke—and I did it to myself—and I didn't even get to *finish* the job. . . .

"Subversion."

"Huh?" said Leo.

"The quaddies have been growing increasingly restive in the past few months. Coincidentally with *your* arrival, Leo." Van Atta's gaze narrowed. "After today's events I wonder if it was a coincidence. I rather think not. Isn't it so that," he wheeled and pointed dramatically at Leo, "*you* put Tony and Claire up to this escapade?"

"Me!" Leo sputtered in outrage, paused. "True, Tony did come to me once with some very odd questions, but I thought he was just curious about his upcoming work assignment. I wish now I'd . . ."

"You admit it!" Van Atta crowed. "You have encouraged defiant attitudes toward company authority among the hydroponics workers, and among your own students entrusted to you, ignored the psych department's carefully developed guidelines for speech and behavior while aboard the Habitat, infected the workers with your own bad attitudes—"

Leo realized suddenly that Van Atta was not going to let him get a word of defense in edgewise if he could possibly help it. Van Atta was onto something infinitely more valuable than mere vengeance for a punch in the jaw—a scapegoat. A perfect scapegoat, upon whom he could pin every glitch in the Project for the past two months—or longer, depending on his ingenuity—and sacrifice qualmlessly to the company gods, himself emerging squeaky-clean and sinless.

"No, by God!" Leo roared. "If I were running a revolution, I'd do a damn sight better job of it than *that*—" he waved in the general direction of the warehouse. His muscles bunched to launch himself at Van Atta again. If he was to be fired anyway, he'd at least get some satisfaction out of it—

"Gentlemen." Apmad's voice sluiced down like a bucket of ice water. "Mr.

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Van Atta, may I remind you that terminations from outlying facilities like Rodeo are discouraged. Not only is GalacTech contractually obligated to provide transportation home to the terminees, but there is also the expense and large time delay of importing their replacements. No, we shall finish it this way. Captain Bannerji shall be suspended for two weeks without pay, and an official reprimand added to his permanent record for carrying an unauthorized weapon on official company duty. The weapon shall be confiscated. Mr. Graf shall be officially reprimanded also, but return immediately to his duties, as there is no one to replace him in them."

"But I was screwed," complained Bannerji.

"But I'm totally innocent!" cried Leo. "It's a fabrication—a paranoid fantasy—"

"You can't send Graf back to the Habitat *now*," yelped Van Atta. "Next thing you know he'll be trying to *un-ionize* 'em—"

"Considering the consequences of the Cay Project's failure," said the Ops VP coldly, "I think not. Eh, Mr. Graf?"

Leo shivered. "Eh."

She sighed without satisfaction. "Thank you. This investigation is now complete. Further complaints or appeals by any party may be addressed to GalacTech headquarters on Earth." *If you dare*, her quirked eyebrow added. Even Van Atta had the sense to keep his mouth shut.

The mood in the shuttle for the return trip to the Habitat was, to say the least, constrained. Claire, accompanied by one of the Habitat's infirmary nurses pulled off her downside leave three days early for the duty, huddled in the back clutching Andy. Leo and Van Atta sat as far from each other as the limited space allowed.

Van Atta spoke once to Leo. "I told you so."

"You were right," Leo replied woodenly. Van Atta nearly purred at the stroke, smug. Leo would rather have stroked him with a pipe wrench.

Could Van Atta be all right, as well? Was his disruptive pressure for instant results a sign of concern for the quaddies' welfare, even survival? No, Leo decided with a sigh. The only welfare that truly concerned Bruce was his own.

Leo let his head rest on the padded support and stared out his window as the acceleration of take-off thrust him back in his seat. A shuttle ride was still a bit of a thrill to something deep in him, even after the countless trips he'd made. There were people—billions, the vast majority—who never set foot off their home planets in their lives. He was one of the lucky few.

Lucky to have his job. Lucky in the results he'd achieved, over the years. The vast Morita Deep Space Transfer Station had probably been the crown of his career, the largest project he was ever likely to work on. He'd first viewed the site when it was an empty, icy vacuum, as nothing as nothing could possibly be. He'd passed through it again just last year, making a changeover from a ship from Ylla to a ship for Earth. Morita had looked good, really good; alive, even undergoing expansion of its facilities, several years sooner than any-

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one had expected. Smooth expansion plans for it had been incorporated into the original designs. Overambitious they'd called it then. Farsighted, they called it now.

And there had been other projects too. Every day, from one end of the wormhole nexus to the other, countless accidents of structural failure did *not* occur because he, and people he'd trained, had done their jobs well. The work of a harried week, the early detection of the propagating micro-cracks in the reactor coolant lines at the great Beni Ra orbital factory alone had saved, perhaps, three thousand lives. How many surgeons could claim to save three thousand lives in ten years of their careers? On that memorable inspection tour, he'd done it once a month for a year. Invisibly, unsung; disasters that never happen don't normally make headlines. But he knew, and the men and women who worked alongside him knew, and that was enough.

He regretted slugging Bruce. The moment's red joy had certainly not been worth risking his job for. The eighteen years of accumulating pension benefits, the stock options, the seniority, yes, maybe; with no family to support, they were all Leo's, to piss into the wind if he chose. But who would take care of the next Beni Ra?

When they returned to the Habitat, he would cooperate. Apologize handsomely to Bruce. Redouble his training efforts, increase his care. Bite his tongue, speak only when spoken to. Even be polite to Dr. Yei. Hell, even do what she told him.

Anything else was impossibly risky. There were a thousand kids up there. So many, so varied—so *young*. A hundred five year olds, a hundred and twenty six year olds alone, cramming the crèche modules, playing games in their free fall gym. No one individual could possibly take responsibility for risking all those lives on something chancy. It would be endless, all-consuming. Impossible. Criminal. Insane. Revolt—where could it lead? No one could possibly foresee all the consequences. Leo couldn't even see around the next corner. No one could. No one.

They docked at the Habitat. Van Atta shooed Claire and Andy and the nurse ahead of him through the hatchway, as Leo slowly unfastened his seat harness.

"Oh, no," Leo heard Van Atta say. "The nurse will take Andy to the crèche. You will return to your old dormitory. Taking that baby downside was criminally irresponsible. It's clear you are totally unfit to have charge of him. I can guarantee, you'll be struck from the reproduction roster, too."

Claire's weeping was so muffled as to be nearly inaudible.

Leo closed his eyes in pain. "God," he asked, "why me?"

Releasing his last restraint, he fell blindly into his future.

CHAPTER SEVEN

"Leo!" Silver anchored one hand and pounded softly and frantically with the other three on the door to the engineer's sleeping quarters. "Leo, quick! Wake up, help!" She laid her cheek against the cold plastic, muffling her bursting howl to a small, sliding "Leo?" She dared not cry louder, lest she attract more than Leo's ear.

His door slid open at last. He wore

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red T-shirt and shorts, barefoot. His sleep sack against the far wall hung open like an empty cocoon, and his thinning sandy hair stuck out in odd directions. "What the hell . . . Silver?" His face was rumpled with sleep, eyes dark-ringed but focusing fast.

"Come quick, come quick!" Silver hissed, grabbing his hand. "It's Claire. She tried to go out an airlock. I jammed the controls. She can't get the outer door open, but I can't get the inner door open either, and she's trapped in there. Our supervisor will be back soon, and then I don't know *what* they'll do to us. . . ."

"Son-of-a . . ." he allowed her to draw him into the corridor, then lurched back into his cabin to grab a tool belt. "All right, go, go, lead on."

They sped through the maze of the Habitat, offering strained bland smiles to those quaddies and downsiders they flew past in the corridors. At last, the familiar door to "Hydroponics D" closed behind them.

"What happened? How did this happen?" Leo asked her as they brushed through the grow-tubes to the far end of the module.

"They wouldn't let me go see Claire day before yesterday, when you brought her back on the shuttle, even though we were both in the Infirmary. Yesterday we were on different work teams. I think it was on purpose. Today I made Teddie trade with me." Silver's voice was smeared with her distress. "Claire said they won't even let her into the crèche to see Andy on her off-shift. I went to get fertilizer from Stores to charge the grow-tubes we were working on, and when I came back, the lock was just starting to cycle. . . ." If only she hadn't left Claire alone—if only she had not let the shuttle take them downside in the first place—if only she had not betrayed them to Dr. Yei's drugs—if only they'd been born downsiders—or not been born at all . . .

The airlock at the end of the hydroponics module was almost never used, merely waiting to become the airseal door to the next module that future growth might demand. Silver pressed her face to the observation window. To her immense relief, Claire was still within.

But she was ramming herself back and forth between door and door, her face smeared with tears and blood, fingers reddened. Whether she gulped for air or only screamed, Silver could not tell, for all sound was silenced by the barrier door, like a turned-down holovid. Silver's own chest seemed so tight she could scarcely breathe.

Leo glanced in. His lips drew back in a fierce scowl in his whitened face, and he turned to hiss at the lock mechanism, scrabbling at his tool belt. "You fixed it but good, Silver."

"I had to do something quick. Shorting it that way blocked the alarm from going off in Central Systems."

"Oh . . ." Leo's hands hesitated briefly. "Not so random a stab as it looks, then . . ."

"Random? In an airlock control box?" She stared at him in surprise, and some indignation. "I'm not a five year old!"

"Indeed not." A crooked grin lightened his tense face for a moment. "Any quaddie of six would know better. My apologies, Silver. So the problem then, is not how to open the door, but how to do so without tripping the alarm."

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"Yes, right." She hovered anxiously.

He looked the mechanism over, glanced up rather more hesitantly at the airlock door, which vibrated to the thumping from within. "You sure Claire doesn't need—more help anyway?"

"She may need help," snapped Silver, "but what she'll get is Dr. Yei."

"Ah . . . right." His grin thinned out altogether. He clipped a couple of tiny wires and rerouted them. With one last doubtful look at the lock door, he tapped a pressure plate within the mechanism.

The inner door slid open and Claire tumbled out, gasping rawly, ". . . let me *go*, let me *go*, oh, why didn't you let me go—I can't stand this . . ." She curled up in a huddled ball in midair, face hidden.

Silver darted to her, wrapped her arms around her. "Oh, Claire! Don't *do* things like that. Think—think how Tony would feel, stuck in that hospital downside, when they told him . . ."

"What does it matter?" demanded Claire, muffled against Silver's blue T-shirt. "They'll never let me see him again. I might as well be dead. They'll never let me see Andy . . ."

"Yes," Leo chimed in, "think of Andy. Who will protect him, if you're not around? Not just today, but next week, next year . . ."

Claire unwound, and fairly screamed at him. "They won't even let me see him! They threw me out of the crèche . . ."

Leo seized her upper hands. "Who? Who threw you out?"

"Mr. Van Atta."

"Right, I might have known. Claire, listen to me. The proper response to Bruce isn't suicide, it's murder."

"Really?" said Silver, her interest sparking. Even Claire was drawn out of her tight wad of misery enough to meet Leo's eyes directly for the first time.

"Well . . . perhaps not literally. But you can't let the bastard grind you down. Look, we're all smart here, right? You kids are smart—I've been known to knock down a problem or two, in my time—we've got to be able to think our way out of this mess, if we try. You're not alone, Claire. We'll help. I'll help."

"But you're a company man—a downsider—why should you . . . ?"

"GalacTech's not God, Claire. You shouldn't have to sacrifice your firstborn to it. GalacTech—any company—is just a way, one way, for people to organize themselves to do a job that's too big for one person to do alone. It's not God, it's not even a being, for pity's sake. It doesn't have a free will to answer for. It's just a collection of people, working. Bruce is only Bruce, there's got to be some way to get around him."

"You mean go over his head?" asked Silver thoughtfully. "Maybe to that vice president who was here last week?"

Leo paused. "Well . . . maybe not to Apmad. But I've been thinking—for three days, I've been thinking of nothing else but how to blow up this whole rotten set-up. But you've got to hang on, for me to have time to work—Claire, can you hang on? Can you?" His hands tightened on hers urgently.

She shook her head doubtfully. "It hurts so much . . ."

"You have to. Look, listen. There's nothing I can do here at Rodeo, it's in this peculiar legal bubble. If it were a

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regular planetary government, I swear I'd go into debt to my eyebrows and buy each and every one of you a ticket out of here, but then, if it were a regular planet, I wouldn't need to. Anyway GalacTech has a monopoly on Jump ship seats here, you travel on a company ship or not at all. So we have to wait, and bide our time.

"But in a little time—just a few months—the first quaddies will leave Rodeo on the first real work assignments. Working in and passing through real planetary jurisdictions. Governments too big and powerful even for GalacTech to mess with. I'm sure—pretty sure, if I pick the right venue—not Apmad's planet, of course, but say, Earth—Earth's by far the best bet, I'm a citizen there—I can bring a class-action suit declaring you legal persons. I'll probably lose my job, and the costs will eat me, but it can be done. Not exactly the life's work I had in mind . . . but eventually, you can be cracked loose from GalacTech."

"So long a time," sighed Claire.

"No, no, delay is our friend. The little ones grow older every day. By the time the legal case goes through, you'll all be ready. Go as a group—hire out—find work—even GalacTech wouldn't be so bad as an employer, if you were citizens and regular employees, with all the legal protections. Maybe even the Spacer's Union would take you in, though that might constrain—well, I'm not sure. If they don't perceive you as a threat . . . anyway, something can be worked out. But you've got to hang on! Promise me!"

Silver breathed again when Claire nodded slowly. She drew Claire away to the first aid kit on the wall, to apply antisepts and plastic bandages to her torn fingernails, and wipe the blood from her bruised face. "There. There. Better . . ."

Leo meanwhile restored the airlock control to its original working order, then drifted over to them. "All right now?" He turned his face to Silver. "Is she going to be all right?"

Silver could not help glowering. "As all right as any of us . . . it's not fair!" she burst out. "This is my home, but it's beginning to feel like an overpressurized oxy bottle. Everybody's upset, all the quaddies, about Tony and Claire. There hasn't been anything like this since Jamie was killed in that awful pusher accident. But this—this was *on purpose*. If they'd do that to Tony, who was so good, what about—about me? Any of us? What's going to happen next?"

"I don't know." Leo shook his head grimly. "But I'm pretty sure the idyll is over. This is only the beginning."

"But what will we do? What can we do?"

"Well—don't panic. And don't despair. Especially don't despair—"

The airseal doors at the end of the module slid open, and the downsider hydroponics supervisor's voice lilted in. "Girls? We got the seed delivery on the shuttle after all—is that grow-tube ready yet?"

Leo twitched, but turned back one last time before hastening away, to grasp a hand of each quaddie with determined pressure. "It's just an old saying, but I know it's true from personal experience. Chance favors the prepared mind. So stay strong—I'll get back to you.

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. . .'' He escaped past the hydroponics supervisor with an elaborately casual yawn, as if he'd merely stopped in to kibbitz a moment upon the work in progress.

Silver's stomach churned as she watched Claire fearfully. Claire sniffed, and turned hurriedly away to busy herself with the grow tube, hiding her face from their supervisor. Silver shivered with relief. All right for now.

The churning in Silver's stomach was slowly replaced by something hot and unfamiliar, filling it, crowding out the fear. *How dare they do this to her—to me—to us? They have no right, no right, no right . . .*

Rage made her head pound, but it was better than the knotting fear. There was almost an exultation in it. The expression Silver bent her head to conceal from the supervisor was a small, fierce frown.

The nutrition assistant, a quaddie girl of perhaps thirteen, handed Leo's lunch tray to him through the serving window without her usual bright smile. When Leo smiled and said ''Thank you,'' the responding upward twitch of her mouth was mechanical, and fell away instantly. Leo wondered in what scrambled form the story of Claire's and Tony's downside disaster of the previous week had reached her ears. Not that the correct facts weren't distressing enough. The whole Habitat seemed plunged into an atmosphere of wary dismay.

Leo felt a flash of horrible weariness of the quaddies and their everlasting troubles. He shied away from a collection of his students eating their lunches near the serving window, though they waved to him with assorted hands, and instead floated down the module until he saw a vacant space to Velcro his tray next to somebody with legs. By the time Leo realized the legged person was the supply shuttle captain, Durrance, it was too late to retreat.

But Durrance's greeting grunt was without animosity. Evidently he did not, unlike some others Leo could name, hold the engineer obscurely responsible for his student Tony's spectacular fiasco. Leo hooked his feet into the straps to free his hands to attack his meal, returned the grunt, and sucked hot coffee from his squeeze bulb. There wasn't enough coffee in the universe to dissolve his dilemmas.

Durrance, it appeared, was even in the mood for polite conversation. ''You going to be taking your downside leave soon?''

''Soon . . .'' In about a week, Leo realized with a start. Time was getting away from him, like everything else around here. ''What's Rodeo like?''

''Dull.'' Durrance spooned some sort of vegetable pudding into his mouth.

''Ah.'' Leo glanced around. ''Is Ti with you?''

Durrance snorted. ''Not likely. He's downside, on ice. He's appealing.'' A twisted grimace and raised eyebrows pointed up the double meaning. ''Not, you understand, from my point of view. I got a reprimand on my record because of that damn tadpole. If it had been his first screw-up, he might have been able to duck getting fired, but now I don't think he has a chance. Your Van Atta wants his pelt riveted to the airlock doors.''

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"He's not *my* Van Atta," Leo denied strenuously. "If he was, I'd trade him for a dog—"

"—and shoot the dog," finished Durrance. A grin twitched his mouth. "Van Atta. That's all right. If the rumor I heard is true, he may not have so long to strut either."

"Ah?" Leo's ears pricked hopefully.

"I was talking yesterday to the Jump pilot from the weekly personnel ship from Orient IV—he'd just finished his month's gravity leave there—listen up to *this* one. He swears the Betan embassy there is demonstrating an artificial gravity device."

"What! How—?"

"Piping it in from wormhole space for all I know. You bet Beta Colony is sitting on the math of it, till they make their initial killing in the marketplace and recoup their R&D costs. It's apparently been kept under wraps by their military for a couple of years already, till they got their head start, damn 'em. GalacTech and everybody else will be on the scramble to catch up. Every other R&D project in the company is going to have to kiss their budget goodbye for a couple of years, you watch."

"My God." Leo glanced up the length of the cafeteria module, crowded with quaddies. *My God* . . .

Durrance scratched his chin reflectively. "If it's true, do you have any idea what it's going to do to the space transport industry? The Jump pilot claims the Betans got the damned thing there in two months—from Beta Colony! —boosting at fifteen *gees* and insulating the crew from the acceleration using it. There'll be no limit to acceleration now but fuel costs. It probably won't affect bulk cargos much for that very reason, but the passenger trade'll be revolutionized. The speed news travels, which'll affect the rate of exchange between planetary currencies—military transport, where they don't care what they spend on fuel—and you can bet *that'll* affect interplanetary politics—it's a whole new game all around."

Durrance finished scraping the last globs of food out of the pockets of his lunch tray. "Damn the colonials. Good old conservative Earth-based GalacTech left in the lurch again. You know, I'm really tempted to emigrate out to the farther end of the wormhole nexus sometimes. The wife's got family on Earth, though, so I don't suppose we ever will . . ."

Leo hung stunned in his straps as Durrance droned on. After a moment he swallowed the bite of squash still in his mouth, there being no more practical way to dispose of it. "Do you realize," he choked, "what this will do to the quaddies?"

Durrance blinked. "Not much, surely. There's still going to be plenty of jobs to do in free fall."

"It will destroy their edge in profitability versus ordinary workers, that's what. It was the downside medical leaves that were boosting the personnel costs. Eliminate them, and there's nothing to choose between—can this thing provide artificial gravity on a space station?"

"If they could mount it on a ship, they can put it on a station," opined Durrance. "It's not some kind of perpetual motion, though," he cautioned. "It sucks power like crazy, the Jump pilot said. That'll cost something."

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"Not as much—and surely they'll find more design efficiencies as they go along—oh, God."

This chance wasn't going to favor the quaddies. This chance favored no one. Damn, damn, damn the timing! Ten years from now, even one year from now, it could have been their salvation. Here, now, might it be—a death sentence? Leo flipped his feet out of the straps and coiled to launch himself toward the module doors.

"You just leaving this tray here?" asked Durrance. "Can I have your dessert?"

Leo waved a hand in impatient assent as he sprang away.

One look at Bruce Van Atta's glum and hostile face, as Leo swung into his Habitat office, confirmed Durrance's story. "Have you heard this artificial gravity rumor?" Leo demanded anyway, one last lurch of hope—let Van Atta deny it, name it fraud. . . .

Van Atta glared at him in profound irritation. "How the hell did you find out about it?"

"It's none of your businesss where I found out about it. Is it true?"

"Oh, yes it is my business. I want to keep this under wraps for as long as possible."

It was true, then. Leo's heart shrank. "Why? How long have you known about it?"

Van Atta's hand flipped the edges of a pile of plastic flimsies, computer printouts and communiques, magnetized to his desk. "Three days."

"It's official, then."

"Oh, quite official." Van Atta's mouth twisted in disgust. "I got the word from GalacTech district headquarters on Orient IV. Apmad apparently met the news on her way home, and made one of her famous field decisions."

He rattled the flimsies again, and frowned. "There's no way around it. Do you know what came in yesterday on the heels of this thing? Kline Station has canceled its construction contract with GalacTech, the first one we were going to send the quaddies out on. Paid the penalty without a murmur. Kline Station's out toward Beta Colony, they must have found out about this weeks ago—months. They've switched to a Betan contractor who, we may presume, is undercutting us. The Cay Project is cooked. Nothing left to do but wrap it up and get the hell out of here, the sooner the better. Damn! So now I'm associated with a loser project. I'll come out reeking with the odor of loss."

"Wrap, wrap how? What do you mean, wrap?"

"That bitch Apmad's most favored scenario. I'll bet she was purring when she cut these orders—the quaddies gave her nervous palpitations, y'know. They're to be sterilized and stashed downside. Any pregnancies in progress to be aborted—shit, and we just started fifteen of 'em! What a fiasco. A year of my career down the tubes."

"My God, Bruce, you're not going to carry out those orders, are you?"

"Oh no? Just watch me." Van Atta stared at him, chewing his lip. Leo could feel himself tensing, pale with his suppressed fury. Van Atta sniffed. "What d'you want, Leo? Apmad could have ordered them exterminated. They're

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getting off lightly. It could have been worse."

"And if it had been—if she had ordered the quaddies killed—would you have carried it out?" inquired Leo, deceptively calm.

"She didn't. C'mon, Leo. I'm not inhuman. Sure, I'm sorry for the little suckers. I was doing my damndest to make 'em profitable. But there's no way I can fight this. All I can do is make the wrap as quick and clean and painless as possible, and cut the losses as much as I can. Maybe *somebody* in the company hierarchy will appreciate it."

"Painless to whom?"

"To everybody." Van Atta grew more intent, and leaned toward Leo with a scowl. "That means I don't need a lot of panic and wild rumors floating around, you hear? I want business as usual right up to the last minute. You and all the other instructors will go on teaching your classes just as if the quaddies really were going out on a work project, until the downside facility is ready and we can start shuttling 'em. Maybe take the little ones first—the salvagable parts of the Habitat are supposed to be moved around the orbit to the Transfer Station, we might cut some costs by using quaddies for that last job."

"To imprison them downside—"

"Oh, come off the dramatics. They're being placed in a perfectly ordinary drilling workers' dormitory, only abandoned six months ago when the field ran dry." Van Atta brightened slightly in self-congratulation. "I found it myself, looking over the possible sites to place 'em. It'll cost next to nothing to refurbish it, compared to building new."

Leo could just picture it. He shuddered. "And what happens in fourteen years, when and if Orient IV expropriates Rodeo?"

Van Atta ruffled his hair with both hands in exasperation. "How the hell should I know? At that point, it becomes Orient IV's problem. There's only so much one human being can do, Leo."

Leo smiled slowly, in grim numbness. "I'm not sure . . . what one human being can do. I've never pushed myself to the limit. I thought I had, but I realize now I hadn't. My self-tests were always carefully non-destructive."

This test was a higher order of magnitude altogether. This Tester, perhaps, scorned the merely humanly possible. Leo tried to remember how long it had been since he'd prayed, or even believed. Never, he decided, like this. He'd never *needed* like this before . . .

Van Atta frowned at him suspiciously. "You're weird, Leo." He straightened his spine, as if seeking a posture of command. "Just in case you missed my message, let me repeat it loud and clear. You are to mention this artificial gravity business to no one, that means especially no quaddies. Likewise, keep their downside destination secret. I'll let Yei figure out how to make them swallow it without kicking, it's time she earned her overinflated salary. No rumors, no panics, no goddamn workers' riots—and if there are, I'll know just whose hide to nail to the wall. Got it?"

Leo's smile was canine, concealing —everything. "Got it." He withdrew without turning his back, or speaking another word.

Dr. Yei was not usually easy to track

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down, it being her habit to circulate often among the quaddies, observing behavior, taking notes, making suggestions. But this time Leo found her at once, in her office, with plastic flimsies stuck to every available surface and her desk console lit like a Christmas tree. Did they have Christmas at the Cay Habitat? Leo wondered. Somehow, he thought not.

"Did you hear—"

Her glum slouch answered his question, even as his white face and rapid breathing finished asking it.

"Yes, I've heard," she said wearily, glancing up at him. "Bruce just dumped the whole Habitat's personnel evacuation logistics on my desk to organize. He, he tells me, being an engineer, will be doing facility dismantling and equipment salvage flow charts. Just as soon as I get the bodies out of his way. Excuse me, the damned bodies."

Leo shook his head helplessly. "Are you going to do it?"

She shrugged, her lips compressed. "How can I not do it? Quit in high dudgeon? It wouldn't change a thing. This affair would not be rendered one iota less brutal for my walking out, and it could get a lot worse."

"I don't see how," Leo ground out.

"You don't?" she frowned. "No, I don't suppose you do. You never appreciated what a dangerous legal edge the quaddies are balanced on here. But I did. One wrong move and—oh, damn it all! I knew Apmad needed careful handling. Everything got away from me. Although I suppose this artificial gravity thing would have killed the project whoever was in charge, we are very, very lucky that she didn't order the quaddies exterminated. You have to understand, she had something like four or five pregnancies terminated for genetic defects, back on her home world when she was a young woman. It was the law. She eventually gave up, got divorced, took an off-planet job with GalacTech—came up through the ranks. She has a deep emotional vested interest in her prejudices against genetic tampering, and I knew it. And blew it . . . She still could order the quaddies killed—do you understand that? Any report of trouble, unrest, magnified by her genetic paranoias, and . . ." she squeezed her eyes shut, massaged her forehead with her fingertips.

"She could order it—who says you've got to carry it out? You said you cared about the quaddies. We've got to *do* something!" said Leo.

"What?" Yei's hands clenched, spread wide. "What, what, what? One or two—even if I could adopt one or two, take them away with me—smuggle them out somehow, who knows?—what then? To live on a planet with me, socially isolated as cripples, freaks, mutants—and sooner or later they would grow to adulthood, and then what? And what about the others? A *thousand*, Leo!"

"And if Apmad did order them exterminated, what excuse would you find then for doing nothing?"

"Oh, go *away*," she groaned. "You have no appreciation for the complexities of the situation, none. What do you think one person can do? I used to have a life of my own, once, before this job swallowed it. I've given six years —which is five and three-quarters more than *you* have—I've given all I can. I'm

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burned out. When I get away from this hole, I never want to hear of quaddies again. They're not my children. *I* haven't had *time* to have children."

She rubbed her eyes angrily, and sniffed, inhaling—tears?—or just bile. Leo didn't know. Leo didn't care.

"They're not anybody's children," Leo growled. "That's the trouble. They're some kind of . . . genetic orphans or something."

"If you're not going to say anything useful, please go *away*," she repeated. A wave of her hand encompassed the mass of flimsies. "I have work to do."

Leo had not struck a female since he was five years old. He removed himself, shaking.

He drifted slowly through the corridors, back toward his own quarters, cooling. And whatever had he hoped to get from Yei anyway? Relief from responsibility? Was he to dump his conscience on her desk, à la Bruce, and say, "Take care of it . . ."

And yet, and yet, and yet . . . there was a solution in here somewhere. He could feel it, a palpable dim shape, like a tightness in the gut, a mounting, screaming frustration. The problem that refused to fall into the right pieces, the elusive solution—he'd solved engineering problems that presented themselves at first as such solid, unscalable walls. He did not know where the leaps beyond logic that ultimately topped them came from, except that it was not a conscious process, however elegantly he might diagram it *post facto*. He could not solve it and he could not leave it alone, but picked uselessly at it, counterproductive like picking a scab, in a rising compulsive frenzy. The wheels spun, imparting no motion.

"It's in here," he whispered, touching his head. "I can feel it. I just . . . can't . . . *see* it . . ."

They had to get out of Rodeo local space somehow, that much was certain. All the quaddies. There was no future here. It was the damn peculiar legal setup. What was he to do—hijack a Jump ship? But the personnel Jump ships carried no more than three hundred passengers. He could, just barely, picture himself holding a—a what? what weapon? He had no gun, his pocket knife featured mainly screwdrivers—right, hold a screwdriver to the pilot's head and cry, "Jump us to Orient IV!"—where he would promptly be arrested and jailed for the next twenty years for piracy, leaving the quaddies to do . . . what? In any case, he could not possibly hijack three ships at the same time, and that was the minimum number needed.

Leo shook his head. "Chance favors," he muttered, "chance favors, chance favors . . ."

Orient IV would not want the quaddies. Nobody was going to want the quaddies. What, indeed, could their future be even if freed from GalacTech? Gypsy orphans, alternately ignored, exploited, or abused, in their dependency on the narrow environment of humanity's chain of space facilities. Talk about technology traps. He pictured Silver—he had little doubt just what sort of exploitation would be her lot, with that elegant face and body of hers. No place for her out there . . .

No! Leo denied silently. The universe was so damned *big*. There had to be a

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place. A place of their own, far, far from the trappings and traps of human so-called civilization. The histories of previous utopian social experiments in isolation were not encouraging, but the quaddies were exceptional in every way. . . .

Between one breath, and the next, the vision took him. It came not as a chain of reason, more words words words, but as a blinding image, all complete in its first moment, inherent, holistic, gestalt, inspired. Every hour of his life from now on would be but the linear exploration of its fullness.

A stellar system with an M or G star, gentle, steady, pouring out power for the catching. Circling it, a jovian gas giant with a methane- and water-ice ring, for water, oxygen, nitrogen, hydrogen. Most important of all, an asteroid belt.

And some equally important absences; no Earth-like planet orbiting there also to attract competition; not on a wormhole Jump route of strategic importance to any potential conquistadors. Humanity had passed over hundreds of such systems, in its obsessive quest for new Earths. The charts were glutted with them.

A quaddie culture spreading out along the belt from their initial base, a society of the quaddies, by the quaddies, for the quaddies. Burrowing into the rocks for protection against radiation, and to seal in their precious air; expanding, leapfrogging from rock to rock, to drill and build new homes. Minerals all around, more than they could ever use. Whole hydroponics farms for Silver. A new world to build. A space world to make Morita Station look like a toy.

"Why," Leo's eyes widened with delight, "it's an *engineering* problem after all!"

He hung limply in air, entranced; fortunately, the corridor was empty of passersby at the moment, or they would surely have thought him mad or drugged.

The solution had been lying around him in pieces all this time, invisible until *he'd* changed. He grinned dementedly, possessed. He yielded himself up to it without reservation. All. All. There was no limit to what one man might do, if he gave all, and held back nothing.

Didn't hold back, didn't look back—for there would be no going back. Literally, medically, that was the heart of it. Men adapted to free fall, it was the going *back* that crippled them.

"*I* am a quaddie," Leo whispered in wonder. He regarded his hands, clenched and spread his fingers. "Just a quaddie with legs." He wasn't going back.

As for that initial base—he was floating in it right now. It merely required relocating. His cascading thought clicked over the connections too rapidly to analyze. He didn't need to hijack a spaceship; he was in one. All it needed was a bit of power.

And the power lay ready-to-hand in Rodeo orbit, being gratuitously wasted even at this moment to shove mere bulk petrochemicals out of orbit. What might a petrochemical pod-bundle mass, compared to a chunk of the Cay Habitat? Leo didn't know, but he knew he could find out. The numbers would be on his side, anyway, whatever their precise magnitudes.

The cargo thrusters could handle the Habitat, if it were properly reconfigured, and anything the thrusters could

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handle, one of the monster cargo Superjumpers could manage too. It was all there, all—for the taking.

For the taking . . .

CHAPTER EIGHT

It took an hour of stalking before Leo was able to catch Silver alone, in a monitor blind spot in a corridor leading from the free fall gym.

"Is there someplace we can talk in private?" he asked her. "I mean really private."

Her wary glance around confirmed that she understood him perfectly. Still she hesitated. "Is it important?"

"Vital. Life or death for every quaddie. That important."

"Well . . . wait a minute or two, then follow me."

He trailed her slowly and casually through the Habitat, a flash of shimmering hair and blue jersey at this or that cross-branching. Then, down one corridor, he suddenly lost her. "Silver . . . ?"

"Sh!" she hissed at his ear. A wall panel hinged silently inward, and one of her strong lower hands reached out to yank him in like a fish on a line.

It was dark and narrow behind the wall for only a moment, then airseal doors parted with a whisper to reveal an odd-shaped chamber perhaps three meters across. They slipped within.

"What's this?" asked Leo, stunned.

"The Clubhouse. Anyway, we call it that. We built it in this little blind pocket. You wouldn't notice it from Outside unless you were looking for it at just the right angle. Tony and Pramod did the outside walls, Siggy ran the ductwork in, others did the wiring . . . the airseals we built from spare parts."

"Weren't they missed?"

Her smile was not in the least innocent. "Quaddies do the computer records entry, too. The parts just sort of ceased to exist in inventory. A bunch of us worked together on it—we just finished it about two months ago. I was sure Dr. Yei and Mr. Van Atta would find out about it, when they were questioning me," her smile faded to a frown in memory, "but they never asked just the right question. Now the only vids we have left are the ones that happened to be stored in here, and Darla doesn't have the vid system up yet."

Leo followed her glance to a dead holovid set, obviously in process of repair, fixed to the wall. There were other comforts: lighting, handy straps, a wall cabinet that proved to be stuffed with little bags of dried snacks abstracted from Nutrition, raisins, peanuts and the like. Leo orbited the room slowly, nervously examining the workmanship. It was tight. "Was this place your idea?"

"Sort of. I couldn't have done it alone, though. You understand, it's strictly against our rules for me to bring you in here," Silver added somewhat truculently. "So this better be good, Leo."

"Silver," said Leo, "It's your uniquely pragmatic approach to rules that makes you the most valuable quaddie in the Habitat right now. I need you—your daring, and all the other qualities that Dr. Yei would doubtless call antisocial. I've got a job to do that I can't do alone either." He took a deep breath. "How would you quaddies like to have your own asteroid belt?"

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"What?" her eyes widened.

"Brucie-baby is trying to keep it under wraps, but the Cay Project has just been scheduled for termination—and I mean that in the most sinister sense of the word."

He detailed the anti-gravity rumor to her, all that he had yet heard, and Van Atta's secret plans for the quaddies' disposal. With rising passion, he described his vision of escape. He didn't have to explain anything twice.

"How much time do we have left?" she asked whitely, when he had finished.

"Not much. A few weeks at most. I have only six days until I'm forced downside by my gravity leave. I've got to figure out some way to duck that, I'm afraid I might not be able to get back here. We—you quaddies have to choose *now*. And I can't do it for you. I can only help with some of the parts. If you cannot rescue yourselves, you will be lost, guaranteed."

She blew out her breath in a silent whistle, looking troubled indeed. "I thought—watching Tony and Claire—they were doing it the wrong way. Tony talked about finding work, but do you know, he didn't think to take a work-suit with him? I didn't want to make the same mistakes. We aren't made to travel alone, Leo. Maybe it's something that was built into us."

"But can you bring in the others?" Leo asked anxiously. "In secret? Let me tell you, the quickest end-scenario for this little revolution I can imagine would be for some quaddie to panic and tell, trying to be good. This is a real conspiracy, all rules off. I sacrifice my job, risk legal prosecution, but you risk much more."

"There are some who, um, should be told last," said Silver thoughtfully. "But I can bring the important ones in. We've got some ways of keeping things private from the downsiders."

Leo glanced around the chamber, subtly reassured.

"Leo . . ." her blue eyes targeted him searchingly, "*how* are we going to get rid of the downsiders?"

"Well, we won't be able to shuttle them down to Rodeo, that's for certain. From the moment this thing comes out in the open, you can count on the Habitat being cut off from resupply." *Besieged*, was the word Leo's mind suggested, and carefully edited. "The way I thought of was to collect them all in one module, throw in some emergency oxygen, cut it off the Habitat, and use one of the cargo pushers to move it around orbit to the Transfer Station. At that point they become GalacTech's problem, not ours. Hopefully it'd ball things up a bit at the Transfer Station, too, and give us a little more time."

"How do you plan to—to make them all get into the module?"

Leo stirred uncomfortably. "Well, that's the point of no return, Silver. There are weapons all around us here, we just don't recognize them because we call them 'tools.' A laser-solderer with the safety removed is as good as a gun. There's a couple of dozen of them in the workshops. Point it at the downsiders and say 'Move!'—and they'll move."

"What if they don't?"

"Then you must fire it. Or choose not to, and be taken downside to a slow

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and sterile death. And you choose for everybody, when you make that choice, not just for yourself."

Silver was shaking her head. "I don't think that's such a good idea, Leo. What if somebody panicked and actually fired one? The downsider would be horribly burned!"

"Well . . . yes, that's the idea."

Her face crumpled with dismay. "If I have to shoot Mama Nilla, I'd rather go downside and die!"

Mama Nilla was one of the quaddies' most popular crèche mothers, Leo recalled vaguely, a big elderly woman —he'd barely met her, as his classes didn't involve the younger quaddies. "I was thinking more in terms of shooting Bruce," Leo confessed.

"I'm not sure I could even do that to Mr. Van Atta," said Silver slowly. "Have you ever seen a bad burn, Leo?"

"Yes."

"So have I."

A brief silence fell.

"We can't bluff our teachers," said Silver finally. "All Mama Nilla would have to do is say "Give that over now, Siggy!" in that *voice* of hers, and he would. It's not—it's not a *smart* scenario, Leo."

Leo's hands clenched in exasperation. "But we must get the downsiders off the Habitat, or nothing else can be done! If we can't, they'll just retake it, and you'll be worse off than when you started."

"All right, all right! We've got to get rid of them. But that's not the way." She paused, looking at him more doubtfully. "Could you shoot Mama Nilla? Do you really think—say—Pramod, could shoot you?"

Leo sighed. "Probably not. Not in cold blood. Even soldiers in battle have to be brought to a special state of mental excitement to shoot total strangers."

Silver looked relieved. "All right, so what else would have to be done? Saying we could take over the Habitat."

"Reconfiguring the Habitat can be done with tools and supplies already aboard, though everything will have to be carefully rationed. The Habitat will have to be defended from any attempt by GalacTech to recapture it while this is going on. The high-energy-density beam welders could be quite effective discouragements to shuttles attempting to board us—if anybody could be induced to fire one," he added with a dry edge. "Company inventory doesn't include armored attack ships, fortunately. A real military force would make short work of this little revolution, you realize." His imagination supplied the details, and his stomach bunched queasily. "Our only real defense is to get gone before GalacTech can produce one. That will require a Jump pilot."

He studied her anew. "That's where you come in, Silver. I know a pilot who's going to be passing through the Transfer Station very soon who might be, um, easier to kidnap than most. Especially if *you* came along to lend your personal persuasion."

"Ti."

"Ti," he confirmed.

She looked dubious. "Maybe."

Leo fought down another and stronger wave of queasiness. Ti and Silver had a relationship pre-dating his arrival. He wasn't really playing pimp. Logic dictated this. He realized suddenly that what he really wanted was to remove

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her as far from the Jump pilot as possible. *And do what? Keep her for yourself? Get serious. You're too old for her.* Ti was what—twenty-five, maybe? Perhaps violently jealous, for all Leo knew. She must prefer him. Leo tried virtuously to feel old. It wasn't hard, most of the quaddies made him feel about eighty anyway. He wrenched his mind back to business.

"The third thing that has to be done first," Leo thought over the wording of that, and concluded unhappily that it was all too accurate, "is nail down a cargo Jumper. If we wait until we boost the Habitat all the way out to the wormhole, GalacTech will have time to figure out how to defend them. Such as Jumping them all to the Orient IV side and thumbing their noses at us until we are forced to surrender. That means," he contemplated the next logical step with some dismay, "we've got to send a force out to the wormhole to hijack one. And I can't go with it, and be here to defend and reconfigure the Habitat both . . . it'll have to be a force of quaddies. I don't know . . ." Leo ran down, "maybe this isn't such a great idea after all."

"Send Ti with them," suggested Silver reasonably. "He knows more about the cargo Jumpers than any of us."

"Mm," said Leo, drawn back to optimism. If he was going to pay attention to the odds against this escapade succeeding, he might as well give up now and avoid the rush. Screw the odds. He would believe in Ti. If necessary, he would believe in elves, angels, and the tooth fairy.

"That makes, um, suborning Ti step one in the flow chart," Leo reasoned aloud. "From the moment he's missed we're out in the open, racing the clock. That means all the advance planning for moving the Habitat had better be done—in advance. And—oh. Oh, my." Leo's eyes lit.

"What?"

"I just had a *brilliant* idea to buy us a head-start . . ."

Leo timed his entrance carefully, waiting until Van Atta had been holed up in his Habitat office nearly the first two hours of the shift. The project chief would be starting to think about his coffee break by now, and reaching the degree of frustration that always attended the first attack on a new problem, in this case dismantling the Habitat. Leo could picture the entangled stage of his planning precisely, he'd gone through it himself about eight hours previously, locked in his own quarters, brainstorming on his computer console after a brief pause to render his programs inaccessible to snoops. The leftover military security clearance from the Argus cruiser project worked wonders. Leo was quite sure no one in the Habitat, not Van Atta and certainly not Yei, possessed a higher key.

Van Atta frowned at him from the clutter of printouts, his computer vid scintillating multi-screened and colorful with assorted Habitat schematics. "Now what, Leo? I'm busy. Those who can, do; those who can't, teach."

And those who can't teach, Leo finished silently, *go into administration.* He maintained his usual bland smile, not letting the edged thought show by any careless gleam or reflection. "I've been thinking, Bruce," Leo purred.

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"I'd like to volunteer for the job of dismantling the Habitat."

"You would?" Van Atta's brows rose in astonishment, lowered in suspicion. "Why?"

Van Atta would hardly believe it was out of the goodness of his heart. Leo was prepared. "Because as much as I hate to admit it, you were right again. I've been thinking about what I'm going to bring away from this assignment. Counting travel time, I've shot four months of my life—more, before this is done—and I've got nothing to show for it but some black marks on my record."

"You did it to yourself." Van Atta, reminded, rubbed his chin upon which the bruise was fading to a green shadow, and glowered.

"I lost my perspective for a little, it's true," Leo admitted. "I've got it back."

"A bit late," sneered Van Atta.

"But I could do a good job," argued Leo, wondering how one could achieve the effect of a hangdog shuffle in free fall. Better not overdo it. "I really need a commendation, something to counterweight those reprimands. I've had some ideas that could result in an unusually high salvage ratio, cut the losses. It would take all the scut work off your hands and leave you free to administer."

"Hm," said Van Atta, clearly enticed by a vision of his office returning to its former pristine serenity. He studied Leo, his eyes slitting. "Very well—take it. There's my notes, they're all yours. Ah, just send the plans and reports through my office, I'll send 'em on. That's my real job, after all, administration."

"Certainly." Leo swept up the clutter. *Yes, send 'em through you—so you can replace my name with your own.* Leo could almost see the wheels turn, in the smug light of Van Atta's eyes. Let Leo do the work, and Van Atta siphon off the credit. *Oh, you'll get the credit for how this project ends all right, Brucie-baby—all of it.*

"I'll need a few other things," Leo requested humbly. "I want all the quaddie pusher crews that can be spared from their regular duties, in addition to my own classes. These useless children are going to learn to work like they never worked before. Supplies, equipment, authorization to sign out pushers and fuel—gotta start some on-site surveying—and I need to be able to commandeer other quaddie spot labor as needed. All right?"

"Oh, are you volunteering for the hands-on part too?" A fleeting vindictive greediness crossed Van Atta's face, followed by doubt. "What about keeping this under wraps till the last minute?"

"I can present the preplanning as a theoretical class exercise, at first. Buy a week or two. They'll have to be told eventually, though, you know."

"Not too soon. I'll hold you responsible for keeping the chimps under control, you copy?"

"I copy. Do I have my authorization? Oh—and I'll need to get an extension against my downside gravity leave."

"HQ doesn't like that. Liability."

"It's either me or you, Bruce."

"True . . ." Van Atta waved a hand, already sinking back gratefully from harried to languid mode. "All right. You got it."

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A blank check. Leo tamped a wolfish grin into a fawning smile. "You'll remember this, won't you, Bruce—later?"

Van Atta's lips too drew back. "I guarantee, Leo, I'll remember *everything*."

Leo bowed himself out, mumbling gratitude.

Silver poked her head through the door to the crèche mother's private sleep cubicle. "Mama Nilla?"

"Sh!" Mama Nilla held her finger to her lips and nodded toward Andy, asleep in a sack on the wall with his face peeping out. She whispered, "For heaven's sake don't wake the baby. He's been so fussy—I think the formula disagrees with him. I wish Dr. Minchenko were back. Here, I'll come out in the corridor."

The airseal doors swished shut behind her. In preparation for sleep Mama Nilla had exchanged her pink working coveralls for a set of flowered pajamas cinched in around her ample waist. Silver suppressed an urge to clamp herself to that soft torso as she had in desperate moments when she was little—she was much too grown-up to be cuddled anymore, she told herself sternly: "How's Andy doing?" she asked instead, with a nod toward the closed doors.

"Hm. All right," said Mama Nilla. "Though I hope I can get this formula problem straightened out soon. And . . . well . . . I'm not sure you could call it depression, exactly, but his attention span seems shorter, and he fusses—don't tell Claire that, though, poor dear, she has enough troubles. Tell her he's all right."

Silver nodded. "I understand."

Mama Nilla frowned introspectively. "I wrote up a protest, but my supervisor blocked it. Ill-timed, she said. Ha. More like Mr. Van Atta has her spooked. I could just . . . ahem. Anyway, I've been turning in overtime chits like crazy, and I requested an extra assistant be assigned to my crèche unit. Maybe when they realize that this foolishness is costing them money, they'll give in. You can tell Claire that, I think."

"Yes," said Silver, "she could use a little hope."

Mama Nilla sighed. "I feel so badly about this. Whatever possessed those children to try and run off, anyway? I could just shake Tony. And as for that stupid Security guard, I could just . . . well . . ." she shook her head.

"Have you heard any more about Tony, that I could pass on to Claire?"

"Ah. Yes." Mama Nilla glanced up and down the corridor, to assure herself of their privacy. "Dr. Minchenko called me last night on the personal channel. He assures me Tony's out of danger now, they got that infection under control. But he's still very weak. Dr. Minchenko means to bring him back up to the Habitat when he finishes his own gravity leave. He thinks Tony will complete his recovery faster up here. So that's a bit of good news you can pass on to Claire."

Silver calculated, her lower fingers tapping out the days unobtrusively below Mama Nilla's line of sight, and breathed relief. That was one massive problem she could report to Leo as solved. Tony would be back before their revolt broke into the open. His safe return might even become the signal for

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it. A smile lit her face. "Thanks, Mama Nilla. That is good news."

Revolution 101 for the Bewildered, Leo decided grimly, should be his course title. Or worse; *050: Remedial Revolution*.

The shell of floating quaddies hovering expectantly around him in the lecture module had been officially augmented by both the off-duty pusher crews, and loaded with all the off-shift older quaddies Silver had been able to contact covertly. Sixty or seventy altogether. The lecture module was jammed, causing Leo to jump ahead mentally and think about oxygen consumption and regeneration plans for the reconfigured Habitat. There was tension, as well as carbon dioxide, in the air. Rumors were afloat already, Leo realized, God knew in what mutant forms. It was time to replace rumors with facts.

Silver waved all clear from the airseal doors, turning all four thumbs up and grinning at Leo, as one last T-shirted quaddie scurried within. The airseal doors slid shut, eclipsing her as she turned to take up guard duty in the corridor.

Leo took up his lecture station in the center. The center, the hub of the wheel, where stresses are most concentrated. After some initial whispering, poking, and prodding, they hushed for him, to an almost frightening attentiveness. He could hear them breathing. *We would need you even if you weren't an engineer, Leo*, Silver had remarked. *We're all too used to taking orders from people with legs.*

Are you saying you need a front man? he'd asked, amused.

Is that what it's called? Her gaze upon him had been coolly pragmatic.

He was getting too old, his brain was short-circuiting to some distant rock-beat, slipping back to the noisier rhythms of his adolescence. *Let me be your front man, baby. Call me Leo. Call me anytime, day or night. Let me help.* He eyed the closed airseal doors. Was the man waving the baton at the front of the parade pulling it after him—or being pushed along ahead of it? He had a queasy premonition he was going to learn the answer. He woofed a breath, and returned his attention to the lecture chamber.

"As some of you have already heard," Leo began, words like pebbles in the pool of silence, "a new gravity technology has arrived from the outlying planets. It's apparently based on a variation of the Necklin field tensor equations, the same mathematics that underlie the technology we use to punch through those wrinkles in space-time we call wormholes. I haven't been able to get hold of the tech specs yet myself, but it seems it's already been developed to the marketable stage. The theoretical possibility was not, strictly speaking, new, but I for one never expected to see its practical capture in my lifetime. Evidently, neither did the people who created you quaddies.

"There is a kind of strange symmetry to it. The spurt forward in genetic bioengineering that made you possible was based on the perfection of a new technology, the uterine replicator, from Beta Colony. Now, barely a generation later, the new technology that renders you

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obsolete has arrived from the same source. Because that's what you have become, before you even got on-line—technologically obsolete. At least from GalacTech's point of view." Leo drew breath, watching for their reactions.

"Now, when a machine becomes obsolete, we scrap it. When a man's training becomes obsolete, we send him back to school. But your obsolescence was bred in your bones. It's either a cruel mistake, or, or, *or*," he paused for emphasis, "the greatest opportunity you will ever have to become a free people."

"Don't . . . don't take notes," Leo choked, as heads bent automatically over their scribble boards, illuminating his key words with their light pens as the autotranscription marched across their displays. "This isn't a class. This is real life." He had to stop a moment to regain his equilibrium. He was positive some child at the back was still highlighting "no notes—real life," in reflexive virtue.

Pramod, floating near, looked up, his dark eyes agitated. "Leo? There was a rumor going around that the company was going to take us all downside and shoot us. Like Tony."

Leo smiled sourly. "That's actually the least likely scenario. You are to be taken downside, yes, to a sort of prison camp. But this is how guilt-free genocide is handled. One administrator passes you on to the next, and him to the next, and him to the next. You become a routine expense on the inventory. Expenses rise, as they always do. In response, your downsider support employees are gradually withdrawn, as the company names you 'self-sufficient.' Life support equipment deteriorates with age. Breakdowns happen more and more often, maintenance and resupply become more and more erratic.

"Then one night—without anybody ever giving an order or pulling a trigger—some critical breakdown occurs. You send a call for help. Nobody knows who you are. Nobody knows what to do. Those who placed you there are all long gone. No hero takes initiative, initiative having been drained by administrative bitching and black hints. The investigating inspector, after counting the bodies, discovers with relief that you were merely inventory. The books are quietly closed on the Cay Project. Finis. Wrap. It might take twenty years, maybe only five or ten. You are simply forgotten to death."

Pramod's hand touched his throat, as if he already felt the rasp of Rodeo's toxic atmosphere. "I think I'd rather be shot," he muttered.

"*Or,*" Leo raised his voice, "You can take your lives into your own hands. Come with me and put all your risks up front. The big gamble for the big payoff. Let me tell you," he gulped for courage, mustered megalomania—for surely only a maniac could drive this through to success—"let me tell you about the Promised Land. . . . ■

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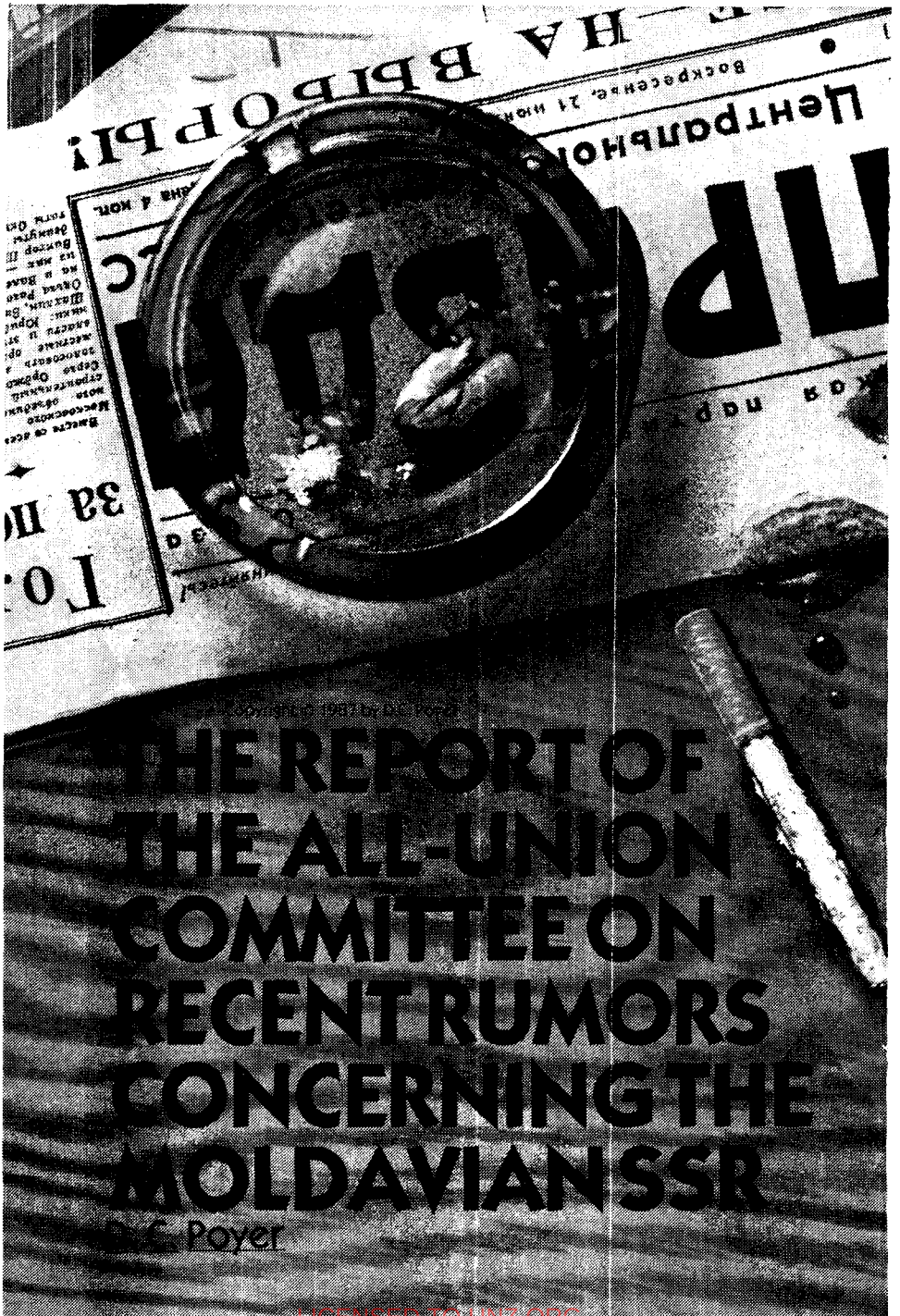

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THE REPORT OF THE ALL-UNION COMMITTEE ON RECENT RUMORS CONCERNING THE MOLDAVIAN SSR

D. E. Poyer

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"So it's finally here." Valentin Sovidov ran his fingers gently over crinkle-finished paint, the slick plastic of a touch-sensitive screen.

"The Trade Mission called yesterday with the release. Academician Uritasky wanted you to start immediately, and so—"

Sovidov was under forty but looked older, a bony man with the neglected look of one to whom nothing matters but work. But this morning he was grinning like a five year old on his name day. It took an effort for him to remove his hands from the console and put them in the pockets of a shiny black suit. "Comrade Colonel . . . it's beautiful. I can hardly believe it's finally here."

The colonel was older, comfortably broad in the blue-piped uniform of the Ministry for State Security. Babchenko frowned. "You know, Valentin Fyodorovich, the USSR makes computers too. And academician Uritasky has always made sure Gosplan had the best."

"That's true. And I'm grateful: he's helped the State Planning Commission make a lot of progress in agriculture. But this—" he reached out again, caught the KGB officer's look, and put his hand behind his back—"This is an ICM 1110R! Its parallel integrative processing and memory capacity makes our ZR series look like slide rules."

"And they're hard to get. We had to trade forty missiles in SALT III to get import permission." Babchenko laughed dryly. "On paper, at least."

"What do you think of it, Laszlo?"

The third man had stood silent, watching the other two and the machine in the brightly-lit room. Laszlo Lugoj was Sovidov's assistant, a fiftyish Hungarian with receding hair. He only nodded, looking displeased, as usual.

"Just out of curiosity, what are you going to use it for?" said Babchenko. "Without the math, please! This little project of yours—"

"It's a *big* project. Gosplan has been trying for fifty years to centralize agricultural planning. It's always failed, because farming has to be tailored to land, crop, even weather. Agriplan-1110 is my idea: an experimental application of the most advanced computer in the world. Professor Lugoj and I will start with the Moldavian SSR, down in the southwest. Their farming's never been very efficient. If we can make computerized agricultural planning work there, the next step is to apply it to the whole Soviet Union."

"I applaud your socialist zeal," said Babchenko. He leaned forward till his finger touched Sovidov's frayed tie. "But stay in touch, all right?"

"Yes, Comrade Colonel."

When the old man had gone (Sovidov felt cold whenever they met; he was an *old Chekist*), he sat down and stared at his new acquisition.

Externally it was unimpressive. All ICM machines were. They tended to blend into the non-decor of data processing centers, nuclear plant control stations, U.S.A.F. Midgetman mobile launch cabooses. Its exterior was sand-colored. It had an integral keyboard and screen, but it interfaced primarily with the high-speed line of ICM optical readers, voxprocessors, and MIRACLE (Multiple Input, RAdio and CabLE) links.

"Why don't you plug it in?" grunted Lugoj.

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Sovidov was gratified to see that the plug fit Soviet receptacles. Apparently ICM had anticipated the voltage difference too, since the machine began to hum and a red "ICMOS DOWNLOAD" light came on.

"This will make history," he said, as much to himself as to his assistant. "The Central Statistical Administration could never interpret agricultural data before it was outdated, but we tried to direct production nonetheless. So year after year harvests came in below targets. Now we'll outdo the Americans —with one of their own machines."

He patted the computer fondly.

In the weeks that followed, Sovidov and Lugoj put in from twelve to fourteen hours daily in the big gray Gosplan building on Karl Marx Prospekt. Their first task was to adapt programs from the older computers to the 1110. (This was relatively easy, since they were all in FORTRAN.) The second was to arrange for a continuous rate of information flow a thousand times greater than Gosplan had previously processed. In two months Dr. Sovidov had initial programming complete, and began input. The 1110 devoured data by the gigabyte. Weather predictions, crop specs, a hectare-by-hectare survey of the Moldavian SSR, pest data, a roster of mechanical, animal, and human resources on the 495 collective, 311 state, and 37 experimental farms, as well as the thousands of private plots, data on fertilizers, electricity, irrigation, everything that bore on agriculture in the Eastern European subdivision of the USSR.

At last it was replete, and Sovidov pressed "ENTER."

The 1110R squatted like Laocoön amid a writhe of cables, filling the room with the hum of blowers. Several minutes passed. Even at its speed, such a problem took time. But then, suddenly, the laser printer came to life, and Sovidov and Lugoj scrambled to stack the floods of paper that spewed out.

From that day on there came from the little office on the third floor of the State Planning Commission a steady stream of marvellously detailed and timely orders. What to plant, when and how, when to spray and water and how much, what hour of what day to reap. The plans went by overnight mail direct to Kishinev, Moldavia. The State Agricultural Administration there, initially doubtful, became believers as the farmers began reporting.

Cabbages, wheat, potatoes, all were ahead of schedule. Insects, predicted and forestalled by the 1110, no longer took a third of the young crops. Fertilizers, applied in tailored doses rather than one massive one, sent each field into an orgy of growth.

Sovidov found that the new machine had even more capability than he had anticipated. So, ignoring some grumbling from Lugoj, he expanded his plans. As soon as Agriplan was working smoothly with crops, he set to work on livestock. He soon had the 1110 producing instructions for the daily diet of each herd of cattle, sheep, and swine in the little republic. The resulting paper got too heavy for the two of them, so he opened a modem link to Kishinev, had them install a high-speed printer, and began sending them instructions in real time.

In late August Sovidov suddenly

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found that he had nothing to do. The data came in automatically on the MIRACLE and went down smooth. He ran the 1110 for fifteen minutes a day, generating instructions; switched on the modem; and that was it. For a couple of days he left at ten AM, but his apartment was bare, the state-run TV boring, and he felt like a social parasite. He searched his mind for another job for his wonderful machine. Late one Saturday night, rereading *Utopia*, he suddenly had it. He could model an entire ecology! Everything living, everything that grew! If it worked he could predict anything: the relationship of purple martins to tobacco production; of bovine flatulence to ozone depletion; even the mythical *optimum solution*, enough food *to support a population with the minimum amount of work*.

His brain reeled. He knew from his studies as a population ecologist that such models had been tried. But never had there been one backed by such power and speed. Rather than the gross detail of physical or analog models, he would be able almost to recreate the mountains and fields, the cities and streams of remote and mountainous Moldavia within the silent dustless corridors of the 1110's memory. He had a beginning. But he needed more. Population statistics, energy inputs, imports and exports, steady numbers from a score of government and Party entities, and a great deal of feedback from Kishinev.

Data aside, the model itself would make the Annual Economic Plan for the USSR look like adding 5 and 5 on an abacus. Sovidov felt his fingers itch for a keyboard. He reached for his telephone (a luxury, but one the Moscow City Exchange deemed necessary for his work). After two rings his assistant's dour voice came over the line. "Who is it?"

"It's Valentin, Laszlo. I've just had an idea."

"That sounds like a lot of work," said Lugoj a few minutes later. "And it's way outside our area of responsibility."

"But agriculture is just a subset of the ecosystem. We need to understand it all, or we don't really understand anything."

"No argument there. But we could be stepping on some toes. Economic Planning. The Party Regional Committees. It's just not our business."

"What kind of attitude is that for a scientist?"

"I'm also a Hungarian," said Lugoj quietly.

"What's that supposed to mean?"

"It means, the less I do and say out of line in Moscow, the better."

"Those days are over, Laszlo."

"Maybe. I still have a bad feeling about it."

"Well, I'm going to try. Are you in or out?"

"In, I suppose," said Lugoj reluctantly. "I suppose you want to start tomorrow."

"Can you make it in by seven?"

With a new goal the weeks flew by again for Sovidov. He put in ever longer hours, seven days a week now, driven by the awesome possibilities. In a sense he and Lugoj and the 1110 would be the creators of a new world, an intangible yet incredibly exact replica of the for-

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ested little country on the Black Sea. Already its geography and economy was locked in the tan cube. Now came data on its population, a dense and cosmopolitan stew from all over Eastern Europe; its industry; its flora, fauna, even its microbial inhabitants, for they too played their role in the seethe of birth and death he was attempting to predict and thus predestine.

Owing to the integrative capabilities of the 1110 he was able to ask simple questions early. He set it to model sheep-raising, and learned that a shift to a certain Siberian breed would allow grazing in the Kodry uplands, displacing 11% of the wild roe deer and producing an additional 7% of mutton and 3.4% of wool with no additional expense.

At last Valentin felt ready to start on his original idea: the quantification of a total energy/biomass system. He began with the land's primary productivity in gram calories per square meter, computing it for the entire Republic. Using this he calculated bioenergy and biomass input to the secondary trophic level (the herbivores: pigs, sheep, rabbits, deer). He had a paper by Glasscock at UCLA that estimated ten percent of initial plant energy made it to these first consumers, and he was gratified to see that the 1110's figure was 9.78%.

Unfortunately, at this point Lugoj refused to work any more overtime. Sovidov couldn't order him to, the man was only on loan, but he felt angry. He worked on alone at night, catching a few hours sleep peasant-style on the 1110's flat warm top.

The complexity and capability of his model increased swiftly now. Late one afternoon, after Lugoj finished the harvest schedule and left, Valentin tackled the next stage. He ordered a gross summary of food resources and asked the machine to correlate that with calculated consumption, expecting to use one figure as a check on the other.

They didn't match. There was 5.5% more food energy reaching the population, according to the figures on rations and purchases, than that trophic level needed. Sovidov frowned. He checked to see that the smaller body weights of women and children had been considered. Whether the residual energy in waste and garbage had been inclined. Whether he'd used the latest figures on imports.

When he reran it he found that the gap widened to nearly six percent.

What was going on? The data indicated overconsumption. But according to everything he knew, that was ridiculous. Moldavians were adequately fed, mainly on potatoes, but only adequately. He sat down and stared at the computer. "I don't understand," he said.

"BOTH MY OPERATING SYSTEMS AND MODEL INTERNAL CONSISTENCY SELF-CHECK," said the 1110. "IF, AS YOU SAY, THE DATA'S GOOD, THEN IT'S SOME BASIC ASSUMPTION THAT'S WRONG."

He was puzzling over this remark when someone rapped on the door. Sovidov was glad of an interruption till he saw who it was. "Colonel Babchenko. What a surprise."

"Thanks." The State Security man took off his cap and sighed. 'Would you

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mind shutting the door? I have a few things to say. Some good, others not."

Sovidov leaned against the computer as if to share its power. "I've not seen you for a few months, Mikhail Semyonovich."

"They said to let you work." Babchenko leaned forward. "Say, the beard looks good. Fills out that cadaverous face of yours."

"Thanks. Actually, I forgot to shave. You said you had news."

"First, something you'll hear shortly from your friend Uritasky. His All-Union Committee on Scientific Agriculture is recommending you for the Lenin Prize."

Sovidov remembered to smile; it meant a new car. "That's good to hear, Comrade Colonel. Was there something more?"

The old man looked past him. "Yes. The machine. It's come to our attention that you're using it for . . . private work."

"So?"

"This computer is State Property. Surely you know the penalties for misuse of State property, Comrade Sovidov."

Lugoj, Valentine thought. His hawk-nosed assistant was the only one who knew. He'd been disappointed at the man's lack of enthusiasm. But he'd never suspected he would inform.

"It's scientific work, carried out on my own time."

"With clearance? With authorization?"

"Well—no."

"Then it must stop."

"Look, Mikhail. I'm not arguing with you, but do you understand what I've been working on at night?"

"No."

"Then listen." Briefly, in terms he hoped Babchenko would understand, he went over his recent work. "But there's an anomaly," he concluded. "There seems to be more food produced than the population requires. That may mean it's being diverted. If I can find out what's happening, we could uncover a major ring of thieves and wreckers!"

He watched the heavy man think it over. Babchenko, as a security officer for scientists, was not a typical KGB thug. At last he shrugged. "It seems all right to me, Valentin Fyodorovich. Perhaps they don't understand what you're doing. Tell you what, I'll report back and let you know. Meanwhile, though, better lay off."

"Of course. Thank you, Comrade Colonel." Sovidov smiled in his beard. Babchenko complimented him again on the medal, refused tea, and left.

But Sovidov spent that night, and the next, at the office, leaving at five for appearance's sake but sneaking back into the darkened building. The illumination of the 1110's console gave him enough light to see, and using the vox-processor he could program in the dark. It was an uncomfortable feeling, whispering in the night like a conspirator; but it seemed to bring him closer to the strange metalogical way it "thought." He began to think of its low vibrating voice (built by ICM for English, it had a definite accent in Russian) as that of an intelligent friend.

But the problem seemed insoluble. A given amount of biomass and energy was being produced by the fields, for-

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ests, and rivers of Moldavia. He could follow its production and its distribution as rationed and open-market food. He could also calculate the needs of the population. Corrected for imports and exports, spoilage and waste, the two should equate. But no matter how late he worked, he couldn't make them match. He had to abandon his first theory, that the food was being stolen. There was a black market, but it couldn't sell food that hadn't been produced; it was already implicit in his figures.

The edges of his new beard grew ragged from chewing. There was something missing, and all his work was useless till he found it.

It was not till late one foggy night on Petrovka Street that he realized what it was.

He had taken a vodka or two and was on his way home. Passing the entrance of an alley, he heard a commotion and stopped. It was two rats. One brown, the other smoky-gray. He paused there, diverted by their snakelike swiftness as they fought over a discarded sandwich. The battle swayed for some seconds, punctuated by squeals, before the advantage shifted to the bigger one, the brown. It seemed to have no inhibitions against cannibalism and Sovidov was turning away in disgust when a sudden soft rush came from above him. As he froze, unbelieving, there was a long pitiable scream, an almost human protest against inexorable doom. Then the black shape lifted, wings beating silently, and only the gray rat was left. It paused, looking up, then began tearing greedily at the garbage.

Sovidov, still looking up into the fog, realized it had been an owl. He was turning to walk on when he realized his basic and fatal mistake.

Human beings were not at the top of the food chain.

He had assumed throughout that energy arriving at the third level was at the end of its use. In cows, to take a simple example, energy intake exceeded their needs because part of it was (inefficiently) converted into human food. But since even in a modern socialist economy people declined to consider conversion of their waste and cadavers into fertilizers, he had considered human consumption of biomass and energy to be its last use.

What if it wasn't? He stared into the alley, listening to the rat gnawing. What if something else was . . . *preying* on the human population? That would account for the higher energy flow. If 4.1 million Moldavians were eating 6% more than their daily requirement, that could mean that some of them —obviously 6% times population times an unknown loss factor peculiar to the trophic interchange mechanism —were living in some other way than consuming food.

Wait—was that right? He paused, massaging his vodka-numbed forehead. No, not as he'd stated the proposition. *Everything* consumed food. What he meant was, the next level obtained bioenergy and mass not from conventional "food," but by siphoning off energy from the human level somehow. It was exactly analogous to a dairy herd. The cows would consume x tons of fodder to support themselves, but x plus delta x if several humans are also living off the herd.

That was why the total energy input

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to the system was higher than he'd calculated it needed. Shaking with excitement, he turned back toward the Gosplan building. He let himself in, fumbling; he could hardly get the key into the lock.

It took only seconds to program the new assumption, and he had to adjust other parameters. But he felt more and more certain, as run followed run, that he had the answer. Toward morning he began getting hard numbers. Finally, at dawn, he shut down and sat in the gray light, thinking. At six he picked up the phone. Babchenko answered immediately. "Late night's work," he explained, sounding as tired as Sovidov felt. "What is it, Valentin Fyodorovich?"

"I need to see you."

"Why?"

"It's about—" Valentin swallowed the rest; he didn't care to talk about it on the phone. "—what we discussed a few days ago."

"Oh? All right. Come on over."

"Over?"

"I'm a busy man, Sovidov. And I'm not exactly on call, you know. You know where to find me."

He stared at the receiver, then eased it into the cradle. He knew, but he didn't like it. Still, he had to tell *somebody*.

Actually Babchenko's office was only a few blocks distant. Sovidov walked quickly along Karl Marx Prospekt, head down, reviewing his logic. He passed the titanic statue of the first Scientific Socialist. Pigeons fluttered up from the pavement, and he thought again of the owl. He passed the great pile of the Hotel Metropol and turned into Dzerzhinsky Square.

The guards stared at him as he approached; when he entered, the men on duty at the desk sat up. The KGB had few walk-in customers. But Babchenko's name cleared the way and a private escorted him up. Sovidov was left to wait in a bare, overheated office, obviously unchanged since Stalinist days. Bare wooden floor, scarred table, a fading on the plaster where the Father and Teacher's portrait had hung for three decades. Sovidov felt it in his stomach. He put his hands in his pockets to keep them from trembling.

The door banged, making him start, and Babchenko came in. His hair was awry, uniform rumpled; he carried a Red Army mug of tea steaming in his hand. "Sit down, Valentin Fyodorovich. Not there, that's mine. Thanks for coming over. Most of the boys have moved to the suburbs, but I prefer the old location. Now, what's the problem?"

He sat, and found his voice after a moment. "Colonel. That—discrepancy in ecological energy I mentioned."

"Right! Have you found out who's stealing it?"

"No, it's not as . . . simple as that." He took a deep breath and plunged into explanation. Babchenko's face became immobile, watching. He finished, "Apparently it's a predator relationship. Natural, once you think about it—any successful and numerous species is going to attract one eventually. I've even got the predator/prey ratio: there are between five and ten of them per thousand humans."

"How do you know that?"

"I made assumptions. That they're the same average size as us, and have

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the same calorie requirements. They just don't obtain energy in the same way."

"Where does it come from, then?"

"Parasitism."

"How?"

"That I don't know. But I'm sure they're there."

"Valentin Fyodorovich," said Babchenko, not unkindly, "you've gone mad, boy!"

"I'm talking science, Comrade Colonel. I'm not explaining it. I'm only reporting it, because I think the authorities ought to know."

"If it were true," the old man mused, "it would be a KGB problem, all right. To find these . . . things . . . take them into custody . . . what am I *saying?* You're overtired. Without proof, you must admit—"

"You want proof?" Sovidov started up; he was frantic to get out of this vast prison. "I'll show you. Come on over."

And after a moment Babchenko nodded, once, and picked up the phone on his desk. "Call my car," he said into it, holding Sovidov's eyes. "This better be good."

"You'll see, Comrade Colonel."

When they got to Gosplan Dr. Lugoj was already there, moodily humming as he set up the morning's crop predictions. "Laszlo," said Sovidov, not bothering to keep sarcasm from his voice, "You know the Colonel, of course."

"We've met."

"I've resolved that anomaly. It's simple. There's a predator class above man."

"I know."

"You *know?*"

"Yes. I was wondering how long it would take you to find out."

"You didn't mention that to me," said Babchenko.

"You didn't ask."

"I don't see how you could have known," said Sovidov. "I only cranked in that assumption this morning."

"It's not exactly a new idea."

"So what does that mean?" said Babchenko. "I want something concrete from you two. Names. Something I can act on. Not pointless talk!"

Lugoj turned sad eyes on him. "Comrade Colonel. Do you really expect to arrest the Undead?"

"The what? Is he serious, Valentin?"

"I hope not. What are you talking about, Laszlo? Some *babushka's* tale you heard as a child?"

"Monsters exist."

"I saw an English film once," grunted Babchenko. "And my grandmother once told me—Ah, this is stupid, a waste of my time!"

"Wait, Colonel. Please." Sovidov tore charts from a pile in the corner, spread them on the 1110 for the old man to see. "I don't know what he's babbling about, but there's *something* going on. See this? It's a food pyramid. Now here's the plant base—grains, mostly; fruits, legumes. These are the energy totals for the various primary sources."

Babchenko said nothing, but since he was looking Valentin hurried on. "Here's the next level—farm animals. See how there are fewer of them. A ten percent conversion ratio. Then, the next steps. There are 4.1-odd million people in Moldavia, making species biomass 2.051×10^8 kilograms. Yet, see, there's

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enough energy input to support 2.17 × 10^8—''

Babchenko relaxed. ''So they're stuffing themselves like the Czar there. So what?''

''No! Foodstuffs are rationed, accounted for. Either there are more inhabitants than we think—unlikely, with our system of internal passports—or else some of those we're counting as humans are *really another level that lives off the third,* with a corresponding drop in efficiency due to the conversion losses.''

''But what your assistant's saying—''

''I'm not responsible for his ravings. I only know what the 1110 tells me. But that's real, Mikhail. It should be looked into.''

He stopped, hoping his voice had carried conviction. It would be all too easy, if Babchenko did not believe him, to end up in a KGB-run psychiatric ward.

''If there is . . .'' said the colonel slowly. He hesitated, then turned to Lugoj, who was standing now by the window, making tea. ''Professor, let's hear what you have to say.''

''Oh, very little. And that you do not believe.'' The Hungarian tipped a flask over the teacup. ''It's a common —myth—throughout Eastern Europe. Hungary, Roumania, parts of Poland and Yugoslavia.''

''We're talking Moldavia,'' said Sovidov.

''Right across the border.''

''Go on.''

''According to folklore they fly, change into wolves or bats, live for centuries . . . and drink the blood of the living, who then become Undead. They have no souls, don't show in mirrors, fascinate women, and fear crosses, garlic, sunlight, and silver.'' Lugoj sighed. ''You suspect a predator? Why *not* a vampire?''

''It's most unscientific.''

''What does that mean? Only that you don't believe what you've yourself discovered. If you must keep your mind closed, don't bother with me, then.'' Lugoj tossed off the dregs and left, closing the door silently.

Babchenko shook himself like an awakening bear. ''Look. Leaving aside all that—we're not exactly friends, Doctor Sovidov, but if I go in with a report like this both our heads may roll. If this is a joke, tell me now. As for your assistant—the less said about *that* the better.''

''It's no joke.''

''I'll send the report up through my channels. You send it by yours. You'll be at your apartment tonight?''

''Yes.''

''Good.'' The KGB man hesitated. ''May I take this chart?''

''By all means.''

''*Do svidaniya,* then.''

''*Do svidaniya,* Colonel,'' said Valentin. ''And—thanks for believing me.''

He made a pretense of working, but his mind was distant. At last he locked up and set out for his flat. In the waning daylight the alley, as he passed it, was no longer mysterious; simply dirty. He examined the nearby roofs, wondering where the bird lived. Imagine, an owl in the middle of Moscow. Well, and why not? Why shouldn't a predator adapt to wherever its prey flourished? That was what evolutionary theory, adaptive radiation, would predict.

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As he lay in bed, staring at the crossed square of light his window cast on the ceiling, he tried to imagine what they might be like. They must look human to the casual observer. There was no way they could hide in the USSR otherwise, with its internal roadblocks and police supervision. But how did they go about (he shuddered) *obtaining their nourishment* from the human population?

Could there be something to Lugoj's nonsense? No, there had to be a natural explanation. Whatever these things were they had to obey natural law. They could not overkill or they would starve. Therefore they were probably territorial, like lions or wolves. Living among humans, they would have to obey rules of camouflage, yet be able to identify their own kind somehow. It was a fascinating problem and despite his fatigue his mind ran faster and faster till it faded finally into dream. A dream that included, whether linked to any reality or not he could not tell, a muffled flapping from outside his tightly locked window.

Some interminable time later something startled him awake. He groped for the lamp and blinked at his wrist. It was 3:10 AM. He got the phone on the second buzz. "Sovidov."

"Valentin Fyodorovich?"

"Colonel. Is something wrong? You sound—"

"Shut up and listen! Get out of your apartment."

"What? I'm sleeping. In the morning—"

"Listen, stupid. The report. I made it, but there's something fishy going on. They wanted your file."

"My file?" Sovidov was still muzzy from sleep. "So?"

"They know where your flat is." Babchenko was whispering; Sovidov thought suddenly, *The old bastard's terrified.* "I'm locked in my office with a revolver. Valentin. Let them know! Somebody upstairs—as high up as you can."

"Upstairs?"

"The scientists—the Presidium—somebody, anybody *outside the KGB*. I think—"

There was a click and the phone died. Then it chattered again, like a little faraway scream, and a voice he had never heard before came on the line.

"Academician Sovidov?"

"This is Sovidov. I was speaking with Colonel Babchenko. We were cut off. Could you reconnect us, please?"

"We can do better than that," said the voice. "We're investigating his report on your research. It's received a high priority. You'll probably be commended for bringing this to our attention. Would you mind coming down to help with the investigation?"

"I've always cooperated with State Security."

"We need more Soviet citizens like you. I'll dispatch a car."

Sovidov hung up. He looked out at the night. Then, on impulse, he lifted the phone again. The Hungarian answered immediately, as if he'd been waiting for the call. "Hello," he said.

"Laszlo? Valentin here."

"What is it, Doctor? Make it short, please."

"Why? Going someplace?"

"I have a taxi waiting."

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"Where are you off to?" said Sovidov, surprised.

"Back to Hungary. Maybe farther. As far as I can go."

"Wait. Listen. I've just had a very strange call."

"I know. He called me too."

"You're not going to help?"

"Help?" repeated Lugoj. "I'm sorry, Valentin. He's honking. If you're smart, you'll run too."

"Run where? I'm staying right here."

The distant voice became hurried. "Valentin, I'm sorry I informed against you. I was trying to stop you. But now it's too late. Listen. Find a cross. Carry it with you. Good-bye."

The line buzzed. Sovidov dialled back, but no one answered. He put it down and shook his head. Had Lugoj gone mad?

Suddenly he knew he had not. Nor had Babchenko. The KGB man was not his friend, but he had tried to warn him. Told him to get the word *upstairs*—

Hastily he pulled on suit and shoes, and reached for the doorknob. Then stopped, frowning. He wavered there, then muttered something and crossed to the bureau. He found it in a box of his old Young Pioneers stuff: a tiny silver Orthodox cross. Pre-Revolutionary—his grandmother's. He examined it, made as if to put it back, and then thrust it into his coat.

Valentin locked the flat and ran down the stairs. He was a half a block from his building when headlights flashed behind him. From the corner of his eye he caught the two white faces in the front seat.

"Comrade Sovidov?"

He could think of nothing to do but walk on, listening to his heartbeat rasp in his ears.

"You in the black suit! Halt, police!"

He paused and half-turned, into the glare of a flashlight.

"Are you Valentin Sovidov?"

He was caught. But some last flicker of self-preservation made him deny even the obvious. "No, I'm not," he said loudly.

"Got the picture?" one of them said.

"Here."

"No, our man's clean-shaven. And the eyes look different."

"Right. Sorry, citizen." Tires squealed in a U-turn, snd Sovidov felt his knees weaken. He ducked into an alley. Where to go? His sister's? No, he didn't want to involve her. Besides, he no longer remembered clearly where she lived, only somewhere near the Kremlin—

Uritasky! He had backed him before. He would listen, he was a scientist; but what was more he had influence, they would listen to him. He would be at his office in the morning. All Sovidov had to do was avoid capture till then. His lip curled at the thought of Lugoj, who could think only of flight, like a frightened rat.

But now he was on the grim night streets of Moscow, tunnels of silent stone and cold concrete and shuttered windows. Two hours till dawn, two more till the government offices opened.

He breathed deep, and resolved to survive.

Hugging the buildings, he slid down Seleznevskaya and turned left. The Russia Cinema loomed ahead, open all night. When an usher finally evicted him it was still dark. He pulled his coat

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close in the chill and loitered down Pushkin Street. When headlights flickered he would step into a doorway and become motionless, part of the gray buildings, the windows filled with bright things for foreign tourists. At any moment he expected something final; wings above him; talons; the hand of a militiaman on his shoulder. For a long time he stood behind a column of the Bolshoi and counted the quarter-hours by the distant chimes of the Spassky Carillon.

But at last came dawn. Women appeared, sweeping the sidewalks. When the streets filled with people coming out of the Metro he joined them. He passed his office, keeping the far side, and saw hard-eyed men near the entrance, scanning the crowd from behind *Pravda*.

He entered the Kreml through the Sobakin Gate. When he saw no one suspicious near the Arsenal he hurried in and ran up a flight to Uritasky's door. A dark young man looked up as he entered.

"Is the Academician in? Sovidov. It's urgent."

"Oh, the Moldavian project. Please go in, Doctor."

Uritasky himself, a strikingly handsome, still dark-haired man, rose as he came in. Sovidov sank gratefully into the chair he was waved to.

"Some tea, Valentin Fyodorovich? I've just come in—"

"I'd love some, thank you, sir."

The administrator touched a button. "You look pale, my man. Haven't seen you for months, since Agriplan began. Isn't that. . . ?"

"Yes. The beard's new."

Uritasky offered him a Cuban cigar, and Sovidov relaxed even more. The office was scientifically cozy. A degree from Lomonosov University hung near a portrait of Uritasky with the Premier. The tea came, carried by the same young man, and Sovidov sipped too quickly and scalded his lips. But the heat was good.

"What brings you here, Valentin? Some problem with the 1110?"

"No, it's running beautifully. It's more a problem with certain results."

For what he hoped would be the last time, Sovidov described his model, his results, and his theory. He finished by recounting Lugoj's fantastic outburst. "He was sure my results confirmed some fantastic superstition about the 'Undead,' as he called them."

"What's your opinion?"

"I think it's a separate species, a true predator. Or parasite, perhaps. At any rate, they look human, but they're not."

"What else can you deduce about them?"

"I've calculated that there are perhaps five thousand of them in Moldavia."

"A sizable problem. That's what brings you here?"

"Yes. I reported these findings to Colonel Babchenko. Then he phoned me early this morning, saying that something was wrong, and asked that I get word to others."

"So you came straight to me."

"Yes sir."

Uritasky frowned into the cloud of cigar smoke. "This is remarkable. And unforeseen—that you stumbled over it in your agricultural research. This predator, however, is not news to us."

"You knew?" Valentin said hopefully. Perhaps Uritasky, or others in

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authority, already had the situation in hand!

"It is a separate species, as you guessed. Probably diverged from the human stock long ago." Uritasky looked out the window; Sovidov followed his glance, to see the sun gleaming on the gilt onion-domes of the Kreml. "And you're right about your assistant's superstitions, too. The metamorphoses, the supernatural powers, all myth. In fact, most of that is deliberate."

"Deliberate?"

"It's rather clever. In the old days the legends kept the peasants cowed. But in the last century, they've achieved something even more useful to them—to make men believe that it's all superstition, that there are no vampires."

"And there are!" said Sovidov, smiling.

"Exactly." Uritasky nodded. "As a higher order, it's not a sinecure for them, of course. They have to plan for their humans' welfare, provide them food . . . much as a farmer cares for his flocks. Until it's time for dinner."

A discreet cough came from behind Sovidov. The secretary and two other men had come in and were standing near the window. He chewed at his beard. He'd been right. But something bothered him still. "But if you knew—why haven't you done anything? They're exploiting the population down there—and—"

When he jumped up someone behind him seized his arms. He twisted free somehow and faced them, panting. They were all young, all dark-haired, all handsome.

"You're all . . . vampires," he said.

"Enlightenment at last," said the minister sarcastically. He rose. "This one is mine. Hold him, gentlemen. Afterward, a fall from the balcony would be tragic, *nyet?*"

Sovidov backed as they approached, till finally he felt the wall. His throat had closed with terror. Then he remembered something. His hand came suddenly out of his coat. Gleaming in the morning sun, the tiny silver cross rotated at the end of its chain, throwing reflections across their faces.

"My dear Valentin," said Uritasky, smiling. He reached out. Took it. Tossed it away, through the window, into the sunlight. "You disappoint me . . . and at the very end. I thought you called yourself a Communist!"

It is the conclusion of the All-Union Committee that recent rumors of so-called "vampirism" are the result of a whispering campaign fomented by CIA agents and other enemies of the people. Soviet citizens are cautioned to be alert for the spreaders of such rumors, and to report at once their names and addresses to the nearest office of the Committee for State Security. . . . ■

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L. Sprague de Camp

State of the Art

RUBBER DINOSAURS AND WOODEN ELEPHANTS

A look back at something that many tend to think of as "new and different"—every time it happens!

I recently relived a big thrill of my youth by seeing a rerun of the 1924 movie, *The Thief of Baghdad*, with Douglas Fairbanks, Senior. As Ahmed the thief, Fairbanks slays a dragon and a giant sea spider. With the help of a winged horse, a cloak of invisibility, and a flying carpet, he wins the Caliph's daughter over the competition of three Asian princes.

In a charming introduction, Douglas Fairbanks, Jr., tells how his father spent two million on *The Thief*, more than had ever been lavished on a movie. While the critics loved it, the picture, though profitable, did not earn so much as Fairbanks hoped; so he was more economical thereafter. A musical score is made up of themes from Rimsky-Korsakov, a perfect choice.

Now and then the motion-picture industry gives birth to a movie on a fantasy or science-fiction theme, such as the Star Wars trilogy or the Conan movies. Sometimes the picture makes a big splash. Then many people, especially younger ones, comment: "Gee whiz, won't this popularize science fiction and fantasy with the general public? Won't it encourage the use of imaginative stories in the movies?"

The speakers do not know that imaginative fiction has been married to the cinema ever since motion pictures began. The very first movies, in our sense, were made beginning in 1900 by the French stage magician George Méliès, using the combined movie camera and projector just invented by the brothers Lumière.

In 1902, among his first half-dozen one-reelers, Méliès produced *A Trip to the Moon*. It included a model space ship, and astronauts and Lunarians chasing one another about papier-mâché sce-

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nery. I did not see it then (I am not *quite* that old!) but long after. Whereas *A Trip to the Moon* was straight science fiction, Méliès followed it next year with a fantasy, *The Kingdom of the Fairies*.

Those unfamiliar with cinematic history, however, often think that each sensational new picture with an imaginative script presents a new departure. As Kipling put it:

In August was the jackal born;
The rains fell in September;
"Now such a fearful flood as this,"
Said he, "I can't remember!"

From Méliès on, movies were wedded as closely to imaginative as to realistic fiction. Not only did the screen facilitate magic and miracles by its illusionistic tricks—stop-motion, double-exposure, blue-screen, and glass work; models and puppets; invisible wires; and so on—but also imaginative fiction is much the older. Realistic fiction only really got started with Daniel Defoe's *Robinson Crusoe* in 1719, while imaginative fiction goes back not only to Plato and Homer but also to prehistoric times.

In 1914 the Australian swimmer, Annette Kellermann, appeared in *Neptune's Daughter*, a fantasy about a magical sea shell. A woman who passes her hand across it is turned into a mermaid and vice versa. At the climax, the villainess smashes the shell in a rage and is turned into an octopus, and served her right.

Miss Kellermann had made a stir with the then shocking one-piece bathing suit. This was what we should call a tank suit. The two-piece suit it displaced was not our two-piece suit—two skimpy strips of fabric sundered by a stretch of skin—but two complete suits, worn one over the other and covering the wearer from neck to knee.

In 1916 appeared a version of Jules Verne's 1870 novel, *Twenty Thousand Leagues Under the Sea*. Captain Nemo's crew are walking on the bottom in diving suits of the old bronze-helmed type when a huge rubber octopus attacks them; but one good whack with an ax sends the cephalopod slithering away. Stevenson's *Dr. Jekyll and Mr. Hyde* appeared in 1920, with John Barrymore flashing his famous profile as Jekyll and wearing a fright makeup as Hyde.

In the 1920s the great German director Fritz Lang (a friend of my old friend, the late Willy Ley) brought out *The Niebelungen Saga*. The first part, *The Death of Siegfried*, was released in the United States in 1923; the second, *Kriemhild's Revenge*, in 1929. Siegfried's battle with the dragon looks suspiciously like Ahmed's similar encounter in *The Thief of Baghdad*. In 1927 came Lang's *Metropolis*, often shown at science-fiction conventions. Therein a mad scientist invents a female robot, who rouses the proletariat against their capitalistic bosses.

The year 1925 saw the outstanding imaginative movie, next to *The Thief of Baghdad*, of the decade: the film version of A. Conan Doyle's *The Lost World*, with Wallace Beery as the terrible-tempered Professor Challenger, Bessie Love as the female lead (a departure from the original story) and a cast of rubber dinosaurs lumbering jerkily about the scene. The dinosaurs were animated by the stop-motion photography pioneered

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by Méliès.

By familiarizing the public with prehistoric life, the movie may even have played a small part in stopping the Fundamentalist crusade against the teaching of evolution. This movement crested in July 1925 in the Scopes trial in Dayton, Tennessee, with Clarence Darrow and William Jennings Bryan trading mighty verbal punches. Nobody anticipated the revival in the 1980s of antievolutionism in the form of "Creation Science" under a Creationist President.

The making of imaginative movies continued with *King Kong* (1933); *Things to Come* (1936, from an original script by H. G. Wells); *Destination Moon* (1950, based upon Robert Heinlein's 1947 novel *Rocket Ship Galileo*); *The War of the Worlds* (1951, from Wells's 1898 novel of that name); and so on down to the Star Trek and Star Wars series, *E. T.*, *Cocoon*, *Alien*, &c. (By the way, I believe I was the first to use "extraterrestrial" as a noun and to use the abbreviation "e.t.," in an article in the May and June 1939 issues of *Astounding*. Advt.)

The more successful imaginative pictures have often been remade. The Barrymore version of *Doctor Jekyll* . . . was the second based upon that Stevenson tale, and a third was produced in 1941. *Twenty Thousand Leagues* . . ., *King Kong*, and *The Lost World* have all been remade in recent decades. The remakes are usually prettier, with the advantages of color and sound; but they seldom exhibit the sheer intelligence that rendered the original versions outstanding.

Thus *The Thief of Baghdad* was redone by Alexander Korda in 1940, with more colorful scenery but a less coherent plot. It showed Baghdad surrounded by towering mountains, whereas anyone who has been there, as I have, knows that Baghdad stands amid the widest, flattest plain on earth. If this plain, the Biblical Plain of Shinar, were scaled down, it could be used as an ironing board.

Douglas Fairbanks, Sr. (1883-1939) was a small, swarthy man (5 feet, 6 inches) with a splendidly developed body. He was a fine all-around athlete and a gregarious extrovert devoted to games, sports, parties, clownery, and practical jokes. His hospitality and bonhommie were fabulous; his lawyer once said: "You wouldn't believe some of the people he put up with. He even liked John Barrymore! That man was so vulgar and vicious that even his makeup man would walk away from him, but Doug thought he was great." (Fritz Leiber, Jr., who also knew Barrymore, does not think him "vicious," merely irresponsible, self-indulgent, and self-destructive.)

Born Douglas Elton Ulman in Denver, Fairbanks attended high school and dramatic school there. Some of his frenetic conviviality may be due to having started life under what were, in the America of the time, two substantial handicaps. He was illegitimate, his father having been married to a woman other than his mother; and he was half Jewish. When Fairbanks was five, the senior Ulman departed. Fairbanks's mother resumed the name of Fairbanks,

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that of the first of her several husbands.

Fairbanks was unusual in the film colony in one way; his good-fellowship was not alcohol-stimulated. He was a teetotaler who would not let drinks be served in his house, until the 1930s when Prohibition had been repealed and his movie career was winding down. Then he permitted a few weak cocktails. His idea of spending a night in a strange town was not to look for liquor, women, or gambling; it was to have a good workout at the nearest gymnasium. From what is now known, a little alcohol would probably have done less to speed his early death than his heavy cigarette smoking.

Arriving in New York in 1899, aged sixteen, he picked up bit parts in the theater, filling "at liberty" times with miscellaneous jobs. He later told colorful tales of adventures during this time, as of attending Harvard or of seeing a bullfight in Spain. These were pure fabrications to bolster his ego, although some of this misinformation got into the article on Fairbanks in the Fourteenth Edition of the *Britannica*.

Such tall tales are to be expected. The qualities that make a good actor have much in common with those of a successful con man. To expect one who has spent his adult life in make-believe to draw sharp distinctions between fact and fancy is unrealistic.

Fairbanks rose rapidly in the theater; he played the lead in a comedy by P. G. Wodehouse, also a beginner. He married a businessman's daughter and in 1909 begat Douglas Jr. In 1915 the Aitken brothers, early filmmakers, lured Fairbanks to Hollywood. With the Kaiserian War raging in Europe, Hollywood was taking the lead in the motion-picture industry away from France.

Over the next five years, Fairbanks appeared in over two dozen films, either cowboy pictures or tales of a tenderfoot who becomes a Real Man under stress. Titles included *The Good Bad Man, The Americano, The Half Breed,* and *A Modern Musketeer*.

Fairbanks became close friends with another rising young star, Mary Pickford, née Gladys Smith and called "America's sweetheart." Born in Toronto, Pickford had even less formal education than Fairbanks and began her stage life at five. When she commenced an affair with Fairbanks, Pickford was married to a drunken actor named Owen Moore. By 1920 she and Fairbanks had shed their spouses and married each other, soon becoming the world's most popular couple.

Among the general American public, the Christian tabu on divorce still had power. To be divorced was a disgrace that could ruin a political or military career. But cinemagoers had become so accustomed to it among theatrical folk that it failed to dent the Fairbankses' vast popularity. A rumor circulated that Moore, coming upon Fairbanks in a public place, had shot him; Fairbanks, with great self-possession, had walked away with the bullet in him. But the incident seems never to have occurred.

By 1920, Fairbanks had his own company, in which he was not only the star but also the producer, the director, and practically everything else, though others might have the formal titles of such

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posts. He now looked around for a new departure from films of the kind he had been making, which were becoming repetitive. He found what he sought in a story in the Munsey pulp, *All-Story Weekly*: "The Curse of Capistrano." To play the masked wrong-righter in Spanish California, Fairbanks learned to fence and made *The Mark of Zorro* (Spanish for "fox"). It proved a smashing success. It was also the first movie I ever thoroughly enjoyed. When I was a boy, my mother had dragged me to pictures of the grim-Russian-tragedy type. They gave me an aversion to all movies, fortunately not lasting.

Having found his métier in films combining the glamour of a period setting and his own rollicking personality, Fairbanks followed *Zorro* by *The Three Musketeers* (1921) and *Robin Hood* (1922). Widely regarded as an agile acrobat who could act a little rather than a serious actor, he essentially played himself: upright carriage, bouncing walk, gleaming smile against his swarthy skin, and a sense of getting enormous fun out of life.

Then Fairbanks tackled *The Thief of Baghdad,* his one true fantasy movie. The success of *Robin Hood* with its huge, costly sets encouraged Fairbankss to go for broke with the sets for *The Thief*. He wrote the script himself under the name of "Elton Thomas." The Russo-Afghan, British-educated writer and adventurer "Achmed Abdullah" (Nadir Khan-Romanoffski) wrote the novelization.

As usual in Fairbanks's costume pictures, his researchers did not always get details right. In *Robin Hood* they hatted their knights in helmets with movable visors, which did not appear till over a century after the time of the story. In *The Thief* they misspelled "Baghdad" as "Bagdad" in the subtitles. The literature on the picture uses both spellings. (The Arabic letter *ghayn*, usually transliterated by *gh*, represents a voiced guttural like French *r* or Dutch *g*.)

The Thief of Baghdad suffered some costly false starts. For a princely parade through the fairy-tale Baghdad, the company made three life-sized model elephants on wheels—neither Indian nor African elephants but a sort of hybrid. In the original release, these elephants appeared for a few seconds only and are hardly visible. Most viewers would not have known of them save that they stood for months in the courtyard of Grauman's Egyptian Theater in Hollywood. In the recent rerun, the wood-and-plaster elephants have disappeared altogether.

Another false start occurred when, to play the wicked Mongol prince, Fairbanks hired a tall, thin, fantastical-looking person named Sadakichi Hartmann. This German-Japanese poet's works included a verse called *Naked Ghosts*, beginning:

Cyanogen seas are surging
On white cinnebarrhine sands . . .

This sounds impressive if you don't know that cyanogen is a colorless poisonous gas and cinnebar a red mineral. When the three princes enter Baghdad to sue for the hand of the Caliph's daughter, the Persian prince, a fat little person of indeterminate sex, rides a

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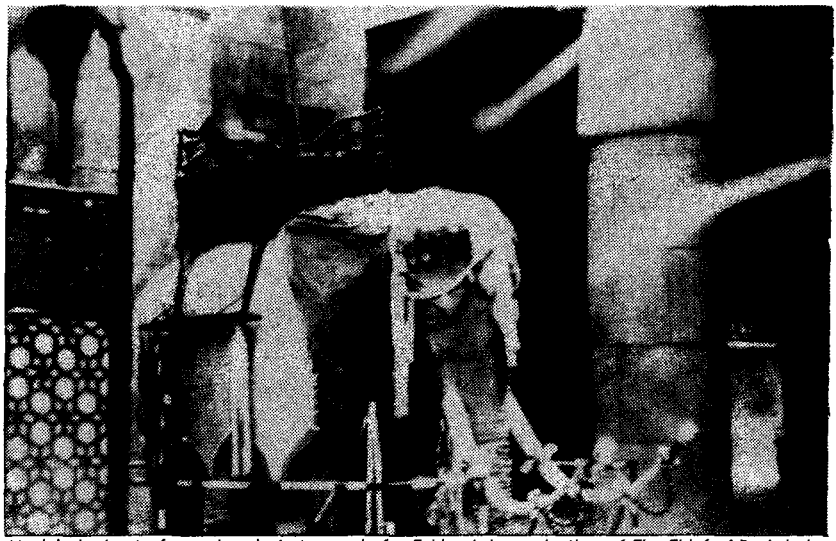

Model elephant of wood and plaster made for Fairbanks's production of *The Thief of Baghdad.* This photograph was made in September 1924, in the courtyard of Grauman's Egyptian Theater in Hollywood, California, with a "Vest Pocket Kodak," a small bellows camera giving a picture 1 ½ by 2 ¼ inches.

camel; the Indian prince rides an elephant (a live one); and the original Mongol prince made his entrance on a sedan chair the size of a mobile home, borne by a troop of servitors.

After some scenes had been shot, Hartmann quarreled with Fairbanks. Rumor said that Hartmann objected to the quality of the drinks served in the abstemious Fairbanks's home. Possibly Hartmann liked his liquor but did not care for Fairbanks's soda pop.

In any case, the picture was made with another Fu-Manchurian menace, a tall, thin Thailander named So-Jin. He arrives in a bigger sedan clair, the size of a minor Egyptian pyramid. But So-Jin never had Hartmann's stage presence. A few clips of Hartmann were salvaged and included in the finished picture, Hartmann being passed off as a court magician.

The thief goes on a quest to save the Caliph's daughter from her unwanted suitors. The princess was played by Julanne Johnston, who has little to do save to look pretty; but this she does very well.

Ahmed meets a fire-breathing dragon, whose underside he slits open with a Malay kris and rather more ease than is plausible. He slays a man-sized bat that attacks him. Then he dives to the sea bottom for a treasure chest. While he examines his find, a gigantic spider sneaks up behind him; but again his trusty kris does its work. In the rerun, besides the wooden elephants, the fight with the giant bat has been deleted, to my disappointment.

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There follows an episode snipped from the 1924 edition but restored in the rerun. A trio of sirens lure Ahmed into a sea-bottom cave fixed up as a boudoir. Whatever their intentions, these are never realized; just in time Ahmed remembers his princess and flees.

The thief mounts a winged horse, which flies to the Castle of the Moon. With the help of a gnomish, transparent Man in the Moon, Ahmed finds a box of magical powder hidden in a cloak of invisibility. He rides back to Baghdad, where the Mongol prince has seized control by means of soldiers smuggled into the city. The Mongol amiably announces that he will now wed the princess and boil his rivals in oil.

With an army created by the magical powder, Ahmed routs the invaders and wins the girl. At the end they fly off on the magic carpet. This flight was staged by suspending the carpet from the boom of a crane.

Modern viewers may wonder why actors of Fairbanks's time did so much acting with their arms, flinging them up and about like windmills. This was not merely the result of being rendered mute. At dramatic school as a boy, Fairbanks probably came under the influence of the Delsartean method of acting.

François Delsarte was a French 19th-century musician and teacher of dramatics and elocution. In Fairbanks's youth, Delsartism was the Latest Thing, the Method, hot stuff. It had a repertory of stylized gestures, one set for each emotion. "Frustration" was conveyed by holding a fist at waist level, smiting an imaginary table top, and simultaneously stamping a foot. When Ahmed, sighting stealable property, expresses "covetousness," he scratches one palm with the fingers of the other hand and then makes grabbing motions in the air.

Another factor in the movie acting of the 1910s and '20s was that many actors and directors came to the infant cinema from the theater. There, because of the distance of most of the audience from the performers, an actor had to use more emphatic gestures and expressions than he would in everyday life. The movie close-up obviated such exaggerations, but these newcomers to that art had already formed their habits and found them hard to break.

During the 1920s, the Fairbankses became the most popular couple in the entire world. On their many foreign trips, they were mobbed by hordes of Arab, Chinese, Greek, Indian, Japanese, Spanish, or Swedish fans. They even received such adulation in the Soviet Union in 1926, when Stalin was consolidating his power by bumping off his old revolutionary comrades one by one. (Some think he poisoned Lenin.) The Fairbankses were the nearest thing the world had to a planetary king and queen. It is perhaps fortunate for the United States that nobody thought to run Fairbanks for President.

After *The Thief*, Fairbanks made more pictures that showed off his skills at leaping, climbing, and performing with exotic implements like the Australian stock whip and the Argentine bolas. His stunts were done with the help of trampolines, piano wires and, for the

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riskiest shots, stunt men. While Fairbanks was personally intrepid and capable of doing the stunts himself, too much money was tied up in a movie to risk laying up the star with a broken bone.

In 1926 Fairbanks produced *The Black Pirate*, silent but in color. The scene where the hero, to destroy a band of pirates, pretends to join them and kills their captain in a duel, was I suspect the model for the similar scene in Robert Howard's Conan story, "Shadows in the Moonlight."

In 1927 came *The Gaucho*, wherein Fairbanks overthrows a South American tyrant. *Don Q* was a sequel to *Zorro*, with Fairbanks playing both Zorro and his son, arrayed against all the villains of nineteenth-century Spain. *The Iron Mask* of 1929 was a sequel to *The Three Musketeers*, more or less following Dumas's two sequels to *Les Trois Mousquetaires*. Sound was coming in, and in some scenes Fairbanks spoke. But his voice proved too high and light to sound very macho.

In 1929, also, he and Pickford jointly produced a movie version of Shakespeare's *The Taming of the Shrew*. Though not at all scholarly, Fairbanks had undergone some exposure to Shakespeare, and he sought advice from the Shakespearean actor Fritz Leiber, Sr. But the film had only modest success. In the 1930s Fairbanks made three more films: *Reaching for the Moon*, a modern comedy with Bebe Daniels and the eminent Edward Everett Horton; *The Private Life of Don Juan;* and finally, in 1934, *Mr. Robinson Crusoe*. Like all of Fairbanks's pictures they made some money, but they had little impact and are virtually forgotten.

Fairbanks was pushing fifty, balding, and no longer quite so lithe and bouncy. Since he had always played a hyperactive young madcap, he had never worked up a stock of aging personae to fall back on for roles. Pickford's career was also winding down, her last picture being *Secrets* (1933). Both had become enormously rich and had invested prudently.

Like most cinematic loves, the romance of the century was also nearing an end. Pickford was getting sated with their incessant globe-trotting, while Fairbanks was finding his wife's drinking ever harder to take. Pickford, who had always liked her liquor, had been ultra-close to her mother, as Robert Howard and H. P. Lovecraft had been to theirs. After her mother died in 1928, Pickford grew into a full-fledged alcoholic. In addition, both suffered acute cases of the actor's occupational disease: narcissism, in the form of an insatiable craving for attention and approval.

Their breakup was long and painful, with partings, reunions, outside love affairs, and reconciliations. Pickford took up with an adoring younger actor, Charles "Buddy" Rogers. Fairbanks, an Anglophile who loved titles, was englamorated by an English showgirl who among her many husbands included a Lord Ashley. After Ashley divorced Sylvia for adultery with Fairbanks, she continued to call herself "Lady Ashley," like American women who marry titled Europeans and, long after they have dumped or been dumped

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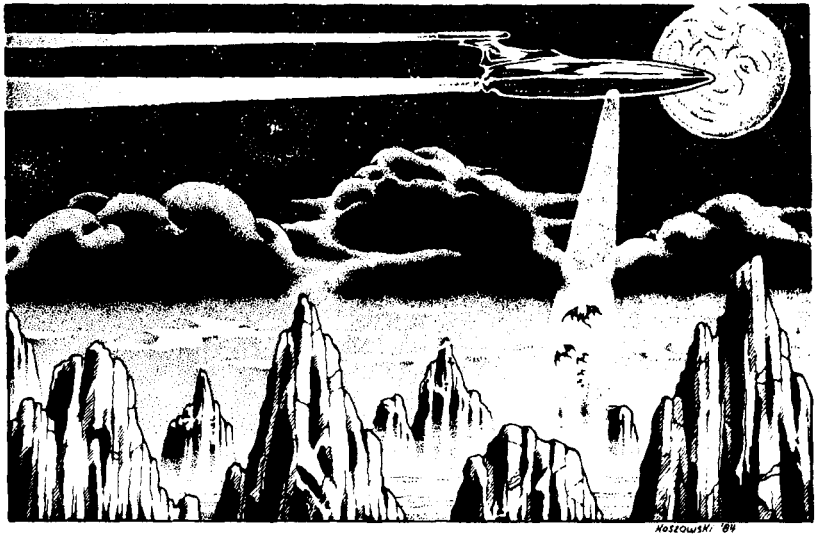
by their spouses, go on forever calling themselves the Baroness von This or the Contessa di That.

After the Fairbanks-Pickford divorce in 1936, each of the pair married his or her new love interest. Fairbanks's new romance did not long endure. In 1939 he died at fifty-six of a series of heart attacks.

Pickford long survived him. She devoted herself to good works like saving Hollywood's rows of palm trees along the boulevards from shopkeepers, who wanted to cut them all down lest a tree block the view of their shops. In Los Angeles she came to be called "the iron butterfly."

One who views old movies may think: Is *this* what they make a fuss about? A silent black-and-white film showing crudely-painted actors moving jerkily and mugging shamelessly? But an appreciation of such a show calls for comparison, not with contemporary films having the benefit of half a century's technological progress and artistic refinement, but with other shows of its time. Much the same adjustment must be made in reading fiction of an earlier time. To judge such a work fairly, one must, to a degree, become as a child again.

The "magic" of a good movie, as of any other work of art, is an elusive thing, subjective, indefinable, and ephemeral. If one can make the necessary mental adjustment and time-travel back to the 1920s, this original *Thief of Baghdad* has all the cinematic magic one could ask for. On its account, Fairbanks, for all his limitations, deserves to be remembered as one of the greatest artists in the development of this art. ■



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The Alternate View

HARDENING HUMANS

G. Harry Stine

For the last forty years, fear of nuclear radiation has been pandemic in our society largely because of its association with the enormous amount of broad-spectrum energy that is released by a relatively small nuclear explosive device. Much of this fear has been caused by the penchant of governments to shroud nuclear explosives in secrecy. Some is undoubtedly due to the fact that we humans have no sensors that will detect radiation in the X ray, gamma ray, and cosmic ray part of the electromagnetic spectrum. A lot of it is caused by the possibility that a terrorist could smuggle a suitcase bomb into almost any place and destroy a square mile of a city.

But, basically a nuclear explosive is just that: an explosive. Explosives have an interesting quirk: The more energetic they are (the more bang per pound), the more difficult it is to set them off or "initiate" them. Black powder is easy to initiate; all it takes is heat energy. Dynamite and nitroglycerine require a brisant shock from something like a dynamite cap. TNT and Composition B, both World War II explosives, are likewise difficult; you can't initiate them with a simple fuse because they require that the initiator send a shock wave into them. Nuclear explosives are extremely difficult to initiate because a series of events must take place on a microsecond basis, and the resulting energy release must be confined by a tamper long enough for most of the reaction to occur; if you don't get the implosion explosives to go off just right, or if the tamper blows away too quickly, you have only a messy dud on your hands.

It's possible to "harden" objects to resist the effects of explosions. Give a military engineer enough concrete or armor, and he'll build a protective device against the blast of any given quantitity of explosives detonated at a given distance. For example, the British have developed a type of armor that protects against hollow-charge warheads; called "Chobham armor," it's made up of alternating sheets of steel and ceramics. Recent non-nuclear tests—large quantities of chemical explosives were used to simulate nuclear blasts—by the Defense Nuclear Agency (DNA) have resulted in the design of weapons storage vaults so hard they'll withstand a major explosion. It's comforting to know that an enemy can't damage or detonate the weapons you have in storage. Only five years ago, building a missile silo to withstand an overpressure of 5,000 pounds per square inch (psi) was pushing the state of the art. Today, missile silos can be built that will survive on the edge of a nuclear crater at overpressures far exceeding 5,000 psi.

Nuclear explosions produce a discernible release of energy in the electromagnetic spectrum just like chemical explosions. (Few laymen realize that very rapid chemical combustion will produce a relatively weak electromag-

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netic pulse or EMP.) Nuclear explosives produce a strong EMP because a lot of energy is suddenly released in a very short time in a very limited volume, and energy that can't leave the system in the form of gamma radiation, X rays, light, and heat gets out in a longer wavelength portion of the spectrum. The EMP from a major nuclear "event" could cause enormous damage to our electric power system because we've strung such long antennas (power lines) conveniently all over North America. EMP also raises hell with the operation of solid-state electronic devices, especially microchips. The United States has spent a lot of time and effort learning how to harden the microelectronic integrated circuitry used in its weaponry as well as in its command, control, communications, and intelligence (C^3I or "C-cubed-I") systems. Lt. Gen. John L. Pickett, Director of the DNA, recently revealed that "we now have the capability of producing a 64-kilobit memory chip that can withstand more than one million rads of ionizing radiation."

That's *hard* because a lethal one-time whole body dose for human beings is 600 rads.

Human beings are by far the "softest" items in modern warfare.

Radiation *per se* is not unhealthy for the human body. We're immune to an average natural background radiation rate of about 200 millirads per year because we've evolved as a species on a planet with this average natural background radiation level. Medical X rays produce about 75 millirads per year of this; natural radiation sources give us an average of 78 millirads per year; the natural radioactive material in our bones produces about 34 millirads per year; and man-made radiation sources give us only about 12 millirads per year. Nuclear workers are permitted to recieve dosages of 300 millirads per week or a total exposure of 46.8 rads in a thirty-year period.

However, too much high-energy radiation in too short a time period in a whole-body dose definitely isn't healthy. At an exposure of 450 rads, there's a 50% chance of death. At 600 rads, the lethality is 100%. The Soviet Union has better data on this than we do. From *highly* reliable sources, I learned that two weeks after the Chernobyl accident, the dose rate 20 kilometers downwind of the site was 450 rads per hour. We have not heard the last of Chernobyl.

At wavelengths in the ultraviolet and above, radiation has enough energy to create damage in living organisms. When a photon with an energy level of about 100 million electron-volts (MeV) or more passes through a living cell, it causes damage because its energy ionizes cell material, stripping orbital electrons and giving cell molecules an electric charge and thus a chemical activity and valence they don't normally have. Such ionized molecules behave differently, and the results are usually deadly. Basically, ionizing radiation kills cells.

(This is widely used in cancer therapy. A close friend of mine recently underwent radiation therapy for inoperable brain tumors. He was exposed to 1,500 rads focused on the tumors. Painful and disturbing and lots of edema around the tumors accompanied by some aphasia and he felt like hell, but

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the tumors were killed in about six weeks.)

The physiological effects of radiation are well known. The tissues of the human body vary in their reaction to ionizing radiation in the following order of sensitivity, the most sensitive being listed first:

1. lymphoid cells
2. the reproductive cells of the gonads
3. bone-marrow cells
4. epithelial cells of the intestines
5. the epidermis
6. hepatic (liver) cells
7. the epithelium of the lungs
8. kidney tissue
9. the cells of the intestinal cavity
10. nerve cells
11. bone cells
12. muscles and connective tissues

Large but sublethal doses affect both the rate of mitosis (cell division) and the synthesis of DNA (in this case, referring to deoxyribonucleic acid). This can lead to diminished production of new cells in tissues that normally undergo continual short-term renewal—bone marrow and gonads, for example. Some cells may be so badly damaged by ionizing radiation that they may continue reproduction but produce abnormal progeny. Some of these altered cells may be malignant.

I covered this information in greater detail in *The Handbook for Space Colonists,* (1985, Holt, Rinehart, and Winston, New York, $11.95, ISBN 0-03-070741-2). In fact, I covered a *lot* of human physiology, psychology, and sociology in that book.

Can a human being be hardened? Apparently, yes, according to work going on in a joint program between the DNA and the Armed Forces Radiobiological Research Institute.

In an October 1986 symposium of the Air Force Association in Los Angeles, California, DNA Director Lt. Gen. John L. Pickett disclosed that significant progress was being made in reducing the effects of ionizing radiation on humans. During the next five years, he announced, they "may be able to reduce the casualties in a fallout environment from ninety percent to as low as ten percent."

After a fashion, Pickett explained, it's possible to "harden" a human being against ionizing radiation by prophylactic measures—ones taken ahead of time. It's therefore possible to inhibit the chemical changes within a cell caused by radiation.

DNA's "human hardening" program starts with dietary supplements rich in green vegetables together with massive doses of Vitamin A (retinol) and Vitamin E (tocopherol). Both are fat-soluble anti-oxidants; both are found in green, leafy vegetables. Vitamin A is stored in the human liver. Vitamin E appears to increase or strengthen the stability of cellular membranes. Together, these prophylactic measures reportedly produce about a thirty percent reduction in the effects caused by ionizing radiation in the cell.

However, the DNA's program goes beyond that to safeguard cell chemical balances by means "not too dissimilar from what we use today in chemical warfare with atropine injections," Pickett said. Atropine (dl-hyoscyamine) is a plant alkaloid which is an anticholinergic or parasympatholic drug that op-

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poses the actions of acetylcholine at postganglionic cholinergic nerve endings and has been found to be effective against Taibun-type nerve gases. All of which means that we are well on our way to developing chemicals that will protect the human body against ionizing radiation. Anything that reduces the casualty rate from ninety percent to ten percent is important!

DNA is also working on post-exposure therapy. This may take care of the remaining ten percent. General Pickett acknowledges that once the human body has gone through major chemical cell changes as a result of exposure to high levels of ionizing radiation, it must be treated as if it had a major illness. DNA is concentrating on intravenous feeding, purging of toxic chemicals from the cells, and the repair of damage to the immune system in order to restore the human body's resistance to infection.

I forecast that this work will have consequences far beyond reducing the physiological effects of massive doses of ionizing radiation.

It is likely to provide critical data that may lead to a cure for AIDS.

It is likely to provide critical data that will result in cures for all known forms of cancer.

And it is likely to be strongly resisted and even fought on emotional grounds by people who believe (a) that AIDS is an expression of God's wrath for the sins of sexual abnormality and promiscuity, and/or (b) that anything which reduces the effects of ionizing radiation and therefore the fear of nuclear warfare will increase the risk of someone initiating such warfare.

I don't think the readers of this magazine will react that way. I bring up the possibility of this sort of resistance so that we may be prepared to counter it and therefore prevent the neo-Luddites from doing their thing.

And, of course, it has obvious consequences when it comes to living and working in space beyond the Van Allen Belts where the threat of heavy doses of ionizing radiation from solar flares is a definite problem. It may permit us to harden ourselves instead of using mass to harden space habitats.

Another example of synergy at work if you take an alternate view of it. ■

IT'S ANLAB TIME AGAIN!

This is our last issue for 1987; it's time once again for you to let us know how we're doing. The authors are interested, I'm interested, and you should be interested—because your feedback about your likes and dislikes will have a second-order feedback effect on what we offer you in the future. So please vote. Here's how:

Look over all your copies of *Analog* from 1987, or refer to the index to 1987 which will appear in our next issue. Pick your *three* favorites in each of the following categories: novella/novelette (a single category), short story, science fact article, and cover. (Since there were only two complete serials, you won't be voting in that category.) Then drop us a line listing your choices, in order of preference. We'll tabulate the votes and let you know how they came out.

Send your votes to: Anlab, *Analog,* Davis Publications, Inc., 380 Lexington Avenue, New York, NY 10017. They must be received by February 1, 1988.

—The Editor

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CHRYSALIS

Gregory Kusnick

The trouble with
long-range plans is
that they allow time
for new variables
to change goals.
Which may not really
be a trouble after all. . . .

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The common room was as crowded as Megan had ever seen it—which was to say, not very. Twenty-four people—the entirety of *Ozma*'s crew—stood in scattered clumps across a space meant for more than twice that many. A generation from now, perhaps, they'd be able to fill this room.

"Places, everyone!" called Gino, the ship's propulsion engineer. "Shutdown in five minutes."

Megan took a chair next to Richard near the center of the circular space, facing the forward arc of the dome. She looked around for Edward, saw him sitting up front with a group of other young people. *Other children,* she was tempted by habit to call them, though by now the eldest had children of their own.

Richard reached for her hand, a cock-eyed smile breaking through the gray of his beard. "Excited?"

"A little," she acknowledged.

Lights dimmed; the dome faded and vanished. Night enveloped Megan, stars swimming in slow arcs around the perimeter of her vision as the ship spun. Ahead, a pale nebulosity, brightest at its center, spread across half the sky: ionized interstellar gas, compressed to visibility as it was funneled back into the engine.

Megan's chin lifted as she followed the flow with her eyes. High above, the kilometer-long ramjet tube, with its field generators and injectors and antimatter tankage, glittered bright in the reflected glare of the drive flame aft. Beyond, just visible through the drive system's open strutwork, the cargo pod's upside-down bulk hung slightly askew on its tether, swept back a few degrees by the ship's minute acceleration.

"Initiating shutdown sequence," Gino announced.

Megan, feeling nothing, searched the heavens for a sign. Slowly the view forward cleared as the scoop fields retracted, allowing the brighter stars to shine through. Above, the drive tube darkened, shifted perspective, tilting ever-so-gradually downward, while beyond it the cargo pod inched into alignment even as it faded to black against the streaming stars.

"Ramjet shutdown complete. Ladies and gentlemen, I give you, once more, our destination: Tau Ceti."

A cheer arose from the assembled crew. Megan returned her gaze to the now unobstructed view forward, and the unexceptional yellow pinprick dead-center in that tilting starscape. *That's it?* she thought, obscurely disappointed. She twisted to look back at Sol, the other pole of her universe, after eight years still by far the brightest star in the sky.

"We have a velocity readout, people," Gino said. "Final speed is about point two three *c*. Projected time of arrival at Tau . . . call it fifty years from now, ship time."

Beside Megan Richard was grinning furiously. "I guess we're really on our way now."

"Right," she said dully. *Fifty years* . . . "On our way."

Tray in hand, Megan stepped from the kitchen niche into the common room proper. Dining tables dotted the circular expanse; starscape projections were spaced at intervals around the lower edge of the dome. Starfields were en-

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joying a new vogue as decor lately, in the weeks since shutdown.

"Over here, Megan."

Spotting Richard's upraised arm, she started across the floor in his direction. Edward was seated with him, she saw, as well as Richard's apprentice Tina. Megan traded nods with the younger woman as she sat.

"Have you heard?" Edward asked excitedly.

Megan's eyebrows lifted. "Heard what?"

"About Richard's Mystery Mass."

"Richard? What's this?"

He grinned. "Just a little something I spotted this afternoon. Or maybe a big something; we're not really sure at this point."

Megan set down her fork in exasperation. "What *are* you people talking about?"

"Let's start at the beginning," Richard said. "You know those astrometric studies I've been working on lately? Observing nearby star systems, using the parallax of the ship's motion to try to pin down some really precise positional information?"

Megan nodded.

"Well, my target this afternoon was UV Ceti—a faint binary just a few degrees off our course, about two-thirds of the way to Tau. Here, I'll show you." He pulled a shipnet access handset from his shirt pocket and spoke softly into it. A nearby section of wall blurred, congealed into a static starfield centered on a pair of dim red dots.

"UV Ceti," he repeated. "Now, do you notice anything funny about this picture?"

She studied it. "No . . ."

"Neither did I, at first. But look, down here in the corner." He thumbed a control on his handset; on the wall a green arrow appeared, tracking across the heavens as he pointed. "This faint double star here? Well, it isn't."

Megan blinked. "Isn't what?"

"Isn't double. Take a spectrogram of it and you find the two components are identical in temperature and composition—even though one's about twenty times brighter than the other."

"Is that bad?"

"It's impossible. It means that what we're seeing here isn't two stars at all, but *two different images* of the same star."

"It's a gravity lens," put in Edward, grinning. "Some compact dark mass between us and that star is doubling the image by bending the light rays passing near it."

"Are you sure?"

"Not at first I wasn't," said Richard. "So I went back through the Archives and found this." A new projection went up on the wall. "This image was taken at Farside Observatory about twenty years ago. Here's UV Ceti here, and this ve-e-ry faint double dot down here is the Mystery Mass, in another gravity lens effect. Parallax puts it maybe a third of a lightyear this side of UV, which means it's just possible the two are in orbit around each other. Personally I doubt it, though; most likely the thing's just passing through. We'd find out for sure if I could get a fresh observation from Farside."

"Assuming there's anybody left at Farside to observe," Tina said abruptly.

Megan looked at her, shocked; she'd almost forgotten the young apprentice

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was present. Tina's eyes shifted, dropped to her half-eaten dinner. "Excuse me," she murmured, picked up her tray and left.

Megan glanced questioningly at Richard, but his eyes warned her to silence. "So, uh," she said after a moment. "Just what is this mysterious object anyway?"

Richard shrugged. "Hard to say. The thing's dark all up and down the spectrum, so there's no clues there. Could be a black dwarf, or a cold neutron star, or even a black hole, I suppose. With the data we have so far, there's just no way to tell."

"So," said Edward reasonably, "let's go there and find out."

"What, you mean a flyby?" Richard's brow creased. "I'm not sure we have the delta-vee to spare for that kind of maneuvering."

Edward frowned right back at him. "Why not? The ramjet—"

"—uses interstellar gas as reaction mass *only*," Richard reminded him. "Forgotten your elementary mechanics already, have you? You can't accelerate the ship without accelerating the gas. Action-reaction, right? And that takes fuel."

"Right, right," said Edward sheepishly. "So, uh . . . how much fuel, in this case?"

"Depends on how close you want to get. Matter of fact . . ." Richard murmured into his handset; on the wall the rectangle of stars went white, began filling with vector diagrams and equations. "Yah. Even with no course change at all, we'll be passing within half a light-year of it, oh, call it thirty years from now."

Edward grimaced. "Half a light's not what I'd call close."

"Maybe not—but I wouldn't want to get *too* close. Not at a quarter *c*, for God's sake. What if there's a dust disk, or something else our shields can't handle?"

"Yeah, good point," Edward conceded. "How about a slow approach, then? Give us more time to study the thing, too."

Richard shook his head. "That I *know* we can't do. Basically, we've got just enough fuel to stop at Tau, with a few grams left over to run the lander. No side trips, no course changes. I mean, I'm as curious as you are, Edward, but I'm afraid that's just the way it is."

"He's right," Megan agreed. "The colony has to take first priority, you see that. There'll be time for this sort of extracurricular exploration after we're established at Tau."

"After *we're* established?" Edward echoed mockingly.

Megan flushed. "You know what I mean." *Fifty years . . .*

"Tell you what, Edward," Richard said. "Since you're so interested, maybe you'd like to work out, as an exercise in mechanics, a trajectory from Tau to the Mystery Mass, figuring in acceleration, fuel load, total trip time, all that sort of thing. Drive specs are in the Archives; ask Gino if he'll help you find them. He's probably got some relevant tutorial software as well."

A reflex protest started from Edward's lips. "But—" Then he stopped, thought about it—nodded. "Okay. You're on."

"Richard," Megan asked him later,

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as they were getting ready for bed. "What did Tina mean by that bit about not being anyone left at Farside?"

Richard paused in his undressing. "Right. That." Hanging up his shirt carefully, he came and sat next to Megan on the edge of the bed. "Well, you know we were expecting to hear from Farside again after shutdown. A sort of 'Hello again' message, so to speak."

Megan nodded. For eight years Sol had been eclipsed behind the white-hot plume of *Ozma*'s exhaust. Now, with the drive off, communication with Earth would again be possible.

She frowned suddenly. "You said '*were* expecting'. Has something changed?"

Richard hesitated, then nodded unhappily. "I'm afraid so. It's been, what, three weeks now with no message?"

"But I mean . . ." Megan spread her hands. "Three weeks out of eight years! Is that something to get upset over?"

"In this case, maybe so. They know our flight plan. Hell, they *computed* it for us. That message should have been here by now."

"Are you sure you're on the right frequency?"

"Yes, we're on the right frequency."

"Well, then maybe *they're* off—"

He held up a hand. "Megan. We know our jobs. Just yesterday Tina ran a sensitive scan of the Solar system over the entire radio spectrum."

"And? No message?"

His lips compressed. "No *nothing*. Earth's not even there at *all*. Normally you'd expect it to shine like a nova in the radio range. That's why Farside's on Farside, if you see what I mean—to get away from all that noise."

Megan felt a sudden chill. "What do you think it means?"

"I don't know," he admitted. "I almost hate to guess." He paused a moment. "Actually, you know, I, uh, promised Tina I wouldn't say anything about this just yet. Not until we can repeat the survey."

"Oh. Sure."

"I think she feels kind of responsible, in a crazy way. Bearer of bad news and all that."

Bad news . . . Megan leaned into Richard's warmth as the import of his words began to sink in. "Is there anything we can do?" she asked, her voice small.

"Not a whole hell of a lot, I'm afraid." His arms came up around her, kneading her shoulders as he spoke. "Tina's already messaged some of the other starships, asking if they know anything about it. But since even the nearest is more than half a lightyear away, we don't expect an answer anytime soon. Meanwhile, we're still listening for that message from Farside—" His voice grew tight. "—and will keep on listening as long as I have anything to say about it."

Clouds whip past the window as the lander knifes down through turquoise skies above rolling cobalt prairies. Beside her Richard grins, squeezes her hand; at her other hand Eddie bounces in boyish exuberance, face pressed against the glass, short legs aswing. The lander swoops low over a deep indigo jungle; in its wake a flock of black dots rises flapping and wheeling from the foliage. Not birds, her biologist's mind tells her, but something else, something

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marvelous and strange. But what? She'll find out. . . .

She stirs, and the alien landscape tumbles away. She looks down on a cloud-wrapped globe turning majestically beneath her. Soon, she tells herself; soon she will be there, the long journey over at last. . . .

Something critical awakes within her. Soon? *The jeweled world recedes, dwindles. She struggles to follow but cannot, can only stare after it as it vanishes, leaving her alone in starry blackness. . . .*

Megan woke in sorrow, the very deep sorrow that only dreams can evoke. *Perhaps that's why we choose not to remember them,* she reflected. Already the images were fading, the emotions paling to a vague emptiness in her breast.

Modular wall panels greeted her opening eyes; the mattress beside her was cold and empty. She glanced at the clock. Almost nine-thirty; Richard would have been through with breakfast an hour ago—just one of the many small differences between them. Sighing, Megan dragged herself wearily out of bed, grabbed her robe from the closet, and headed for the shower.

Setting aside her trowel, Megan reached for the bag of dried recycler sludge and salted a handful into each of the six holes she'd dug. Strong synthetic sunlight warmed her shoulders; somewhere nearby a honeybee droned in search of fresh blooms. Megan picked a culture tube from the tray, inverted it, shook the infant *Erodium* into her palm.

She'd found the unusual variety in the cryo vault a few weeks ago, there amongst the vegetable cultivars, frozen human embryos, and other Earthlife gene samples needed by the Tau colony. Curious, she'd cloned up half a dozen seedlings, which she now set carefully into the prepared earth. With a last sprinkling from her watering can, Megan sat back on her heels to inspect the result.

She sighed. It wasn't working. For some reason the normally therapeutic gardening activity today failed to touch the vague melancholy she felt. She looked around the narrow ring-shaped terrace. Gray lunarglas hull panels peered from gaps in the foliage. Naked grow lights glared from dangling fixtures below a ceiling mazed with pipes and ductwork. And beyond, unseen but ever present, the endless interstellar night.

Megan stood, slowly, respectful of the extra tenth-*g* of pseudogravity prevailing here in *Ozma*'s nether reaches, and moved to the rail that guarded the inner edge of the terrace. From here, high up the side of the hemispheric bowl, the ag floor had the look of a giant dartboard done in pastel earth tones. Fish tanks, dwarf orchards, stands of wheat and soy alternated outward in checkered sectors from the center, where the square shaft of the service core scored a perfect bull's-eye.

A dark figure moved among the varied crops: Verne, *Ozma*'s agronomist and Megan's right arm in Biosystems administration. Seeing her, Verne waved and made for the central elevator shaft. A few moments later he was stepping off the catwalk onto Megan's terrace.

"Congratulate me," he said. "I'm gonna be a granddaddy."

Megan blinked. "Jamie's pregnant?"

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He nodded, teeth flashing.

"But she's just a kid!"

"She's twenty-three next month, Megan."

"Oh." She tried hard to share Verne's enthusiasm. "That's great, Verne. Really. But . . ."

He raised an eyebrow. "But?"

"Well . . ." She sighed. "I do wish these youngsters would think to coordinate with us first. After all, we're the ones who have to feed them and their children."

"Yeah, well." Verne shrugged. "*Vox populi* and all that."

Megan nodded sourly. A few years back she and Verne had coauthored a proposal to regulate births according to a centrally programmed schedule. The load on the ship's biosystems, they argued, was better increased smoothly than haphazardly. Reaction in the shipnet opinion forums had been swift and scathing, and they'd quickly withdrawn the idea. In *Ozma*'s captainless society, the administrator who defied shipnet consensus soon found herself powerless, the controls of her equipment refusing her commands.

A tone sounded from speakers set into the ceiling. "Your attention, please, everybody. This is Tina in Communications. Sorry to interrupt, but I thought you all should know."

Megan traded glances with Verne, her throat suddenly dry.

"I'm receiving a transmission from the starship *Frank Drake* en route to Epsilon Eridani," Tina continued flatly. "*Drake*, if you'll recall, left Earth about a year before we did; this message is a bit more than six months old." There followed a short silence, punctuated by occasional clicks.

The new voice was remote, urgent, overlaid with a whistling hiss: "*Hello,* Ozma, *this is Earth ship* Frank Drake *calling* Ozma. *Please respond if you can. It is now six months since shutdown and as yet we have been unable to re-establish contact with Earth. Broadband radio and optical surveys show no detectable artificial signals, no human-made signals of any kind, anywhere in Sol system. Can you offer any explanation for this,* Ozma? *We've been tracking your exhaust, so we know you got away . . .*"

A sudden roaring filled Megan's ears; she grabbed the guard rail, blinking, waiting for her vision to clear. An anxious Verne stood beside her, one hand on her shoulder. "Megan? You okay?"

She nodded, waving him to silence.

"*. . . afraid we must conclude,*" the voice from *Drake* was saying, "*that some catastrophe has rendered Earth incapable of radio communication.* Ozma, *if you have* any *information to contradict this, please,* please *let us know.*"

The voice clicked off, to be replaced by Tina's bleak tones. "There's more, but that's the gist off it. The complete text is indexed under Communications, *Drake*, this date, if anybody cares." The speakers went dead.

So that's it then, Megan thought dully. *It's just us now.* Just *Ozma, Drake*, a handful of other ships: tiny capsules of life, flung like seeds from the dying Earth, in search of fertile ground in which to take root.

She shivered. *I hope to God we find it.*

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Hands slack atop the keyboard, Megan stared at the overlapping display frames—taxonomic charts, gene sequence data, video stills of plant specimens—chewing her lip absently. This new *Erodium* variety: a strict cladist would put it over here, of course, in *this* subgenus, based on molecular compatibility data. Traditionally, though, it went over *here*, on structuralist grounds.

Megan squeezed her eyes shut. Concentration was difficult; her mind kept seeing past the organism in hand to the microcosm of Earthly life, suspended in *Ozma*'s vault, of which it formed a part. That subset, just days ago dauntingly large in its diversity, seemed now a pitiably small endowment on which to found a world.

A knock came at the office door. Frowning, Megan layered a readout of her schedule on top of the already cluttered wall display. If that was Ian, he was early. Well, she wasn't getting much done anyway. "Come in."

It wasn't Ian.

"Edward," she said, surprised. "What can I do for you?"

He took a chair across the desk from her. "I assume you got my solution for the Tau-to-Mystery-Mass trajectory?"

"I got it," she acknowledged. "*Though frankly I don't see what it has* to do with me."

His mouth tightened fractionally. "Didn't you read it?"

"Well, I—" Megan's face grew warm. "*I glanced through it, of course.* I'm afraid I don't have a lot of spare time these—"

"Right," he cut her off. "I'll explain it to you, then. Basically the idea is to expand my results into a full-blown mission plan, with research agenda, instrumentation requirements, the works. A realistic plan that we could actually—" He caught himself. "—that *somebody* could actually carry out. What I'm trying to do now is get together a study group to work on the concept. . . ."

Megan stared at him. She wanted to scream, to grab him by the shoulders and shake, hard. Earth was silent, off the air, *dead* for all they knew, and here he was babbling about some obscure exploratory mission that at best might not happen for centuries. It all seemed so absurd, so spectacularly *irrelevant*.

"Edward," she said, breaking into his monologue. "I can't imagine why you thought this would interest me."

He blinked, taken aback by her bluntness. "But—I mean, with your unique skills—you know everything there is to know about biosystems, practically—"

She snorted. "Spare me the flattery."

A rap at the door reminded her: *Ian*. "Just a minute," she called.

Edward's eyes, when she returned to them, were hooded, accusing. "You think it's a stupid idea."

"No, I—" She sighed. Why must it always be this way between them? "Look, Edward, I'll think about it, all *right? But I really am rather busy* lately—"

"Yeah, right," he said stonily, eyeing her wall display. "Rearranging the geranium family tree, I guess that must be pretty damn important." He stood. "Sorry to take up so much of your precious time."

He thumbed the door open to reveal a thin, balding man on the other side.

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"Oh. Hello, Edward. I'm not interrupting, I hope?"

"No, Ian. I'm through here."

"A moment, then, before you go. Perhaps I can ask a favor of you."

Edward stood aside as Ian entered. "What?"

The older man hesitated. "For some time I've felt it would be wise to augment the formal historical records in the Archives with our own personal recollections of Earth. That's why I'm here now, in fact: to interview Megan."

Edward grunted. "Naturally."

"I feel it's important," Ian continued, "to preserve everyone's impressions, children as well as adults. Take yourself for instance. You were, what, twelve at the time of departure?"

"Thirteen."

"Even better. So if I might have permission to access your schedule and set up an appointment for us to talk—"

"Sorry, Ian. I'm busy."

Ian blinked. "But surely you see the importance—"

"Surely *you* see," Edward countered testily, "that I've got important work of my own to do. Nostalgia I leave to you two *adults*." The door sighed shut behind him.

Ian pivoted, bemused, to face Megan. "A moody young man, your son."

Megan said nothing.

"Yes. Well." Hesitantly, Ian seated himself in the chair Edward had vacated. "Are we ready to record?"

Megan roused herself, focused on the historian's face. "I suppose."

"Good." He drew out his handset, spoke briefly into it, set it face up on the desk between them. "I thought we might start with your involvement with the starship advocacy movement. You were something of a leader in that movement, from its very earliest days if I'm not mistaken."

"That's right," Megan acknowledged. "Though in fact it was largely an accident that I got involved at all."

"Oh?" said Ian, intrigued. "How so?"

"Well, I was just out of school then—twenty-three, twenty-four years old—working an apprenticeship aboard the O'Neill One habitat . . .

The space colony's corridors were packed with revelers, plastic nametags showing midnight-black against their "Space Is A Place" and "Go Climb A Gravity Well" T-shirts.

"What's going on?" Megan asked, stopping one of them in the hall. "Some kind of convention?"

"L5 Society," he told her. "Fiftieth anniversary."

She studied him: young, bearded, good-looking, with the pale complexion and attenuated build of a Lunarian, his thin shoulders slumped a bit in the O'Neill's Earth-standard pseudogravity. "I didn't know L5 was still around."

"Well, it's not—really and hasn't been since the '80s. We kind of revived it for the occasion. These days we all pay our dues to the Citizens of Space coalition." He grinned. "But hey, any excuse for a party, right?"

Megan smiled back. "I guess."

The youth stuck out a hand. "I'm Richard, by the way. In the astrophysics program over at Farside."

"And I'm Megan," she said, accepting his grip. "Biosystems engineering, right here in O'Neill."

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"Ah, so you're the one who keeps all this running."

Megan laughed. "Hardly. My job's mostly grunt work, mopping up swill from the aquaculture tanks, feeding the recyclotron—fun stuff like that." She sighed. "Maybe someday . . ."

"Right," said Richard. "Meanwhile, though, there's a big banquet on tonight, where we all vote ourselves back out of existence. Strictly symbolic, of course, but it should be fun. Jim Watson-Barr's scheduled to speak, and Ellie Woodward, and a bunch of other CoS celebs. Interested? I can get you in if you like; I'm on the committee."

He was right: it *was* fun. The young astronomer's connections were impressive; he managed to come up with a pair of seats just a few tables from the podium. And as the all-night parties metamorphosed into breakfast bull sessions, Megan was astonished to find herself enjoying champagne, coffee, and strawberry waffles with Woodward and Watson-Barr themselves, along with a number of lesser luminaries.

The table talk bounced randomly from topic to topic. Richard confirmed the rumor, circulating at the convention, of oxygen lines detected in the atmosphere of Alpha Centauri A III—the first firm evidence of life in that nearby planetary system. A few minutes later Woodward was telling them of her own work on cheap catalytic production of antimatter.

"You know what this means, don't you?" Watson-Barr interrupted.

"No," said Woodward. "What does it mean?"

"Well, we've got the destination." He nodded at Richard. "We've got the biosystems expertise; that's you, Megan." She blushed. "Now we've got the fuel, too."

"Fuel for *what?*" Megan asked.

Watson-Barr blinked. "Starships, of course."

And so it was that Megan came to be a founding member of the Centauri Society, dedicated to promoting the idea of interstellar colonization. Before the last cup of coffee had been drained the group had drawn up a charter, elected officers, chipped in to form a treasury, even sketched out a preliminary publicity campaign.

"To Far Centaurus," Watson-Barr intoned, raising his champagne glass. "May we all live to make the Trip!"

Nevertheless it was a good fifteen years before *Heinlein* left orbit bound for Alpha III. And busy years they were. Megan worked hard to live up to the expectations of her fellow Centaurians, putting in long hours on the Society's volunteer study panels, over and above her regular work of maintaining, upgrading, and ultimately managing the O'Neill biosystems. When at last the starship program became a budgeted reality, it seemed only sensible to trade her by then largely administrative job at O'Neill for a full-time position with the program's cutting-edge design team.

Now the work began in earnest. As the ships took shape, Richard and Megan found themselves spending as much time apart as together, flitting from orbital autofacs to Earthside scientific conferences to Lunar observatories to hands-on supervision at the L4 construction site. Megan's parents were a Godsend, looking after Edward in their New

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England home sometimes for months at a stretch while his parents were busy elsewhere.

For his part, Edward didn't seem to mind. On the contrary, he enjoyed his Earthside "vacations" immensely, returning to orbit full of tales of snowball fights with Grandpa, of lobster dinners and moonlight beachcombing and sailing to Nantucket in a 16-foot sloop, with nothing but water as far as the eye could see. It was a great shock to him, and to Megan too, when the old couple died suddenly, their boat overturning in a storm, a few months before *Ozma*'s departure.

"You know, it's funny," Megan mused. Ian waited, quietly, letting her thoughts work themselves out. "All along there'd been this berth with my name on it, right? Just for being a principal in the program. A kind of recruiting inducement; you remember how it was. And ones for Richard and Edward too, if we wanted them. Perks of the job, if you will, and it was just sort of *assumed* we'd be using them. A lot of our friends planned to—Gino and Carlotta, you and Jill—and a lot more were already gone, shipped out aboard *Heinlein* or *Drake* or one of the others."

She shook her head, slowly. "So there I was, and there was this ticket to Tau . . . and now here I am, eight years later, ten trillion kilometers from home . . . and I'm *still* not sure just how it happened."

Edward's notion of a Mystery Mass exploratory expedition spread like measles through the crew, dominating mealtime conversation and shipnet discussion forums. The younger members—those who had come aboard as children—seemed particularly susceptible, devoting themselves whole-heartedly to the project.

Megan found the excitement hard to fathom; these last few years of solitary research seemed to have immunized her against that kind of contagious enthusiasm. Her *Geraniaceae* reclassification continued to absorb the bulk of her attention, while the weekly progress reports from Edward's growing group piled up, unread, in her message queue.

Finally, though, she got around to clearing out the backlog. By then Edward's original bare-bones mission plan had elaborated into a many-authored document of complex topology, bristling with annotations and cross-linked a hundred ways to itself and to the Archives. The thrust of the research seemed to have changed as well, Megan noted uneasily.

One apparently popular focus of speculation concerned the habitability of the Mystery Mass system. Whatever the object's current nature—black dwarf, neutron star, or black hole—it must already have passed through a red giant stage, engulfing and absorbing any Earthlike worlds that may once have existed. Whatever planetary system remained would likely consist primarily of small icy bodies captured from UV Ceti's cometary cloud.

Such worldlets would of course orbit in almost total darkness. Apart from its gravitational effects, the Mass itself remained undetectable. This put a limit on its brightness such that even from one AU, the radius of the Earth's orbit, it would be at best a bright star, and

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possibly much dimmer. The twin suns of UV Ceti were no help; a third of a light-year distant, they'd be all but invisible.

To Megan it all sounded unbelievably dismal. Not so to the project participants; here were schemes for mining the comets for fuels, using their mineral resources to build permanent space habitats—even a proposal by Verne to enclose a small iceberg in a plastic bag, fit it with grow-lights, and turn it into a giant agricultural complex.

Megan had to smile a bit at that; it seemed her "unique skills" weren't so irreplaceable after all. But what did all this have to do with investigating the Mystery Mass?

"Richard." She stood in the doorway of the cubicle, eyeing the shifting pattern of charts and projections on the wall.

"Mm?" He slouched at his desk, fingers moving briskly over the keyboard. "What's up?"

Megan entered slowly. One of the projections, she noted, was a color-coded schematic chart of Edward's proposal, with its maze of interlocking note boxes and reference icons. She gestured. "What do you think of it? Edward's plan, I mean."

Richard shrugged distractedly, eyes on the display. "It's a good plan."

"That's not what I mean. I know a colonization plan when I see one, Richard. Heaven knows I've worked on enough of them."

"So? Nothing wrong with that."

"But—" She sighed. "You don't understand. This isn't just an academic puzzle. Edward's serious, Richard. He really means to go there. Himself. Personally."

Richard gestured dismissal. "We've been through all that. It can't be done." He paused a moment, thoughtful. "Still, can you blame him? I mean, what's he got to look forward to at Tau? Except the chance to be buried there."

Megan's throat tightened. "I'd give my soul for that chance," she said quietly.

He sat up then and looked at her, hands falling idle into his lap. "I know. But you have to realize not everybody feels the way you do."

"What about you?"

"Hm?" He colored slightly. "What about me?"

She eyed him keenly. "You're one of them, aren't you? You want to go there as much as anybody."

"For Christ's sake, Megan," he said, annoyed. "Of course I want to go there. Hell, I *discovered* the damn thing. You think my curiosity stops there?"

She dropped her eyes, saying nothing.

"The thing is," he went on, "it doesn't matter where I want to go, or where Edward wants to go. The *ship* goes to Tau, and there's nothing any of us can do about that."

This time the common room was set up as a lecture hall, dining tables pushed aside, chairs arranged in rough rows facing a podium at one side of the dome. The chairs were alive with people, the people with conversation. Megan saw numerous handsets in use; on the wall behind the lectern, the by-now familiar schematic of Edward's project plan zoomed and scrolled erratically in re-

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sponse to the murmured commands of the crowd.

Edward himself stood off to one side, absorbed in some computation of his own. Graphs and equations flickered hypnotically before him, faster than Megan could follow. After a few moments he nodded in satisfaction and strode to the lectern.

"Okay," he said, "thanks for coming, everybody." On the wall behind him a blue transcript box opened, capturing his words as he spoke. "It's good to know you all share my enthusiasm for this project."

Megan, sitting alone at the back of the crowd, folded her arms and said nothing.

Edward waved a hand at the displayed schematic. "You're all familiar with the basic mission plan, right? What I want to do is talk about some new developments that affect the plan. Ah—" He hesitated. "Richard, why don't you start by reviewing what we know about the Mystery Mass."

He stood aside as Richard took the podium. Megan frowned, eyeing the pair of them suspiciously.

"The big news is we've observed another lensing incident," Richard began, bringing out his handset. On the wall one of the reference boxes expanded to show a dense starfield, a pair of faint dots within it marked by a blinking circle. "This time we were ready. Besides good position information, we managed to get some sensitive measurements of the relative brightness of the lensed and unlensed images, which gives us a handle on the lensing object's mass. Tough break for you black hole fans, but the thing just doesn't seem to be heavy enough; our best estimate puts it around one point six solar masses."

His eyes scanned the crowd. "Put it all together and it spells neutron star. An extinct pulsar, I'd guess, exact age unknown but probably on the order of a few billion years. Oh, and we've refined our distance figures a bit as well; the object is three point nine one light-years from Tau, about a twenty-four-year trip in an *Ozma*-class starship."

"How far from our current position?" Edward asked him.

Richard consulted his handset. "I make it seven point one one light-years."

A sly smile played on Edward's lips as he drew his own handset. "Let's see, at our current speed, plus deceleration time . . . that's about thirty-four years from here."

Richard frowned. "Sounds right, but so what? It's not as if we can go there directly. It's too far off course; we just don't have the fuel."

"We don't need fuel." Edward was grinning openly now. "See, if we can just *deflect* the oncoming gas, without changing its energy, then the ship gets deflected too, without changing *its* energy. Action-reaction, right? Like using the ram scoop as a rudder."

The room went silent. Megan's breath caught.

"Numbers," Gino spoke up suddenly. If anyone knew what the scoop fields could—or couldn't—do, it was Gino. "Give me numbers."

"Sure." Edward spoke to his handset; a large graphics frame unfolded within his transcript box on screen.

The discussion waxed technical. Megan tuned it out, her eyes on Richard,

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who followed Edward's exposition avidly, a kind of cautious elation in his face.

"You're talking some pretty tiny effects here," said Gino finally. "That gas is *thin*. It'll take years to turn as much as a single degree."

"True." Edward shrugged. "But then, we've *got* years."

"What about drag?" Richard asked him. "Using the fields like that with the drive turned off is bound to slow us up some."

"Some," Edward admitted. "I figure a couple of percent, tops. Call it thirty-five years instead of thirty-four."

Megan could see the numbers working in Richard's head. *Thirty-five years, versus fifty years to Tau. A man in his mid-forties might*— His lips pursed in speculation. *Oh, Richard,* Megan thought dispairingly.

That same computation was being repeated in heads throughout the audience. "Well?" Edward asked of them, echoed in bold type by the blue-edged transcript. "What do you say? We've got the plan. We've got the means of carrying it out. Shall we leave it to our descendants, then? They'll face challenges enough, wherever we go. But *this* challenge—" He waved at the complex overlay of charts and diagrams behind him. "This challenge could belong to us. Not to our grandchildren, or to their grandchildren, but to *us*, to our generation."

A murmur rose from the crowd. Opinion boxes mushroomed on the wall, in approving green, neutral gray, the occasional cautious yellow, as crew members registered their reactions.

"*Wait* a minute!" Megan stood, fumbling for her handset. The box she summoned was an angry red, her words unreeling rapidly inside it as she spoke. "Aren't you forgetting something? There's a *world* waiting for us at Tau, a complex, mysterious, *living* world. What are neutron stars compared to that? All our lives we've dreamed of exploring that world. And now you want to throw that dream away?"

"Your dream, Megan," said Edward. "Not ours."

"Yeah," Verne agreed. "Let the other ships colonize their planets. We got ourselves a unique opportunity here to do something different. Be crazy not to take it."

Megan stared at him. "You too, Verne?"

"Hell, yes," he replied. "I'd like to live to see a thing like that Mystery Mass. Wouldn't you? 'Stead of dying halfway to Tau?"

"But—" She faltered. *Cobalt plains and indigo forests . . . jeweled globe dwindling into the distance . . .* "But where would we *live?*" She looked to Richard, still standing awkwardly by the podium, but he would not meet her eyes.

"Look," said Edward. "I'm not wild about spending the rest of my life aboard ship, if that's what you're driving at. But at this point I don't really have a choice, do I? And neither do you. Dragging us all to Tau isn't going to change that."

Megan's knees folded, and she slumped back into her seat. On screen, the opinion boxes continued to bloom, burying her spent anger beneath a lapping green tide.

* * *

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Ship's night. Maintenance lights glimmered in regular ranks against the unfinished ceiling; below, on the ag floor, sprinklers hissed invisibly, scenting the air with dewy freshness. Megan wandered the dark circular path of her garden, shrubs nodding and whispering as she passed, stroking her outstretched hands with delicate feather touches.

An old fantasy came to mind: herself, stooped and wrinkled, patiently transferring these gardens plant by plant into the soil of the new world. She shook her head. Foolish hope. For them, the plants, there would be no new world. For her . . .

She glanced involuntarily over the rail. Down there, beneath the dirt of the ag floor, the recycler waited, its hatch quite large enough—by her own design—to accept a shrouded human corpse.

A clank followed by a rising whine drew her attention to the service core. Above, a pale spot of light descended through the ceiling, a bogus moon settling toward her horizon. She watched it draw level; there were more clunks, then the cage door opened. "Megan?"

She nodded to herself, there in the gloom. "Over here, Edward."

He made his way hesitantly along the catwalk; Megan moved to meet him at its outer terminus.

"I thought I might find you down here," he said.

She grunted. "Glad to be so predictable."

His voice was pained. "I didn't mean—"

"I know." She laid a hand on his arm. "Forget it."

She turned, resumed her walk; Edward fell in beside her, in silence but for the scuffling of their footsteps and the remote hiss of the sprinklers. After a time she said, "Edward?"

"Mm?"

"If you'd had the choice . . . would you have stayed behind?"

He was a long time answering. "Christ, I don't know. I mean, I was thirteen years old! How could I know what it would be like? Leaving *or* staying." A pause, shorter this time. "What about you? If you'd had the choice."

Megan allowed mild surprise to enter her voice. "But I did have a choice." *Didn't I?*

After another quarter-circuit he spoke again. "Tina thinks she's figured out a way of using the pulsar as a communications beacon."

"Is that so?" said Megan.

"Uh huh. What you do is you dump a lot of mass on it, see, which heats it up, spins it up, and starts it radiating again. It happens sometimes in nature, she says, only much slower, usually. We figure if anything's going to get Earth's attention, a resurrected pulsar ought to do it."

She stopped, looked at him. "You think big, don't you?"

"Yeah, well." He smiled crookedly, his face half-shadowed in the dimness. "There's a few engineering hurdles, but we think it can be done. Someday."

Down below, the sprinklers cut off suddenly, leaving an eerie, almost expectant quiet. The quiet of a seed in its hull, Megan thought; of a worm in its cocoon. Who could say when that silence would end, that chrysalis burst, releasing something new and alive into the universe?

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Who could stop it, when it happened? Life is growth, and change, and becoming ever new. Life adapts, or dies.

She sighed. "You really think there's a place for people in this pulsar system?"

He shrugged. "If not, we'll make a place."

"Mm." She nodded. "Well, I wish you luck."

"Wish *me* luck?" said Edward. "Come on. You're, what, forty-seven now?" He grinned. "And *stubborn*. I bet you make it."

"Perhaps," she replied, the ghost of a smile on her lips. "We'll see." ■

ON GAMING

(continued from page 61)

Dana Kramer wrote the game novel in serviceable, if uninspired, prose. Since this isn't a book review, I won't go into any great analysis other than to say that Kramer gets the action moving along at a pretty good pace.

The story of the novel is about Lieutenant Commander Emerald Sheller's attempt to bring her space fleet into position to save Captain Hope Hubris's beleaguered force from being crushed by space pirates. Since Anthony's work is enthusiastically space opera, we're sort of dealing with a faster-than-light version of the Battle of Leyte Gulf.

The game system is intriguing since it has, in the *Combat Command* series, a fairly sophisticated set of rules. Each ship has five values, for Manpower, Ordinance, Attack Strength, Melee Strength, and Stealth. There is also a rating for Morale to indicate the fighting spirit of your troops. Combat, which is pretty much what this series is about, is conducted by comparing Attack Strength (Manpower times Ordinance) with the roll of two dice. There are a series of charts to determine the damage done when the ship's Attack Strength is cross referenced with the dice roll.

Each ship is rated for Attack Strength and, during combat, you are told what chart to use. *Cut by Emerald* also features special rules covering elapsed time and loss of ships. The time chart adds a good amount of pressure, as arriving intact but too late is pointless.

(As Woody Allen said, "Eighty percent of life is about showing up on time.")

Despite a slow start, *Cut by Emerald* keeps the action bouncing along and I found myself quite caught up in the large-scale battles. With many strategic maps and extensive combat, *Cut by Emerald* is more of a game than most game novels, and it will be interesting to see other works in the series, to be based on Robert A. Heinlein's *Starship Troopers*, David Drake's *Hammer's Slammers*, and Roger Zelazny's *Amber* series. ■

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Jane Jewell

Standing from left to right: William F. Battista, Gardner Dozois, Roger MacBride Allen, Rick Cook, James Patrick Kelly, Stanley Schmidt, Michael F. Flynn; Sitting: Tom Kidd, Sheila Williams, Connie Willis, Tina Lee, Isaac Asimov

THE 1986 ANALYTICAL LABORATORY

For those of you who might have missed our June issue, here's a recap of all the winners:

"Eifelheim," *Michael F. Flynn*—Best Novella
"Phreak Encounter," *Roger MacBride Allen*—Best Short Story
"The Long Stern Chase: A Speculative Exercise," *Rick Cook*—Best Fact Article
May: *Tom Kidd* for *Marooned in Real Time*—Best Cover

The awards presentation was held at the United Nations Plaza Hotel in New York City on June 17, 1987, in conjunction with *Asimov's* Readers' Awards. The cocktails and hors d'oeuvres were plentiful, and the many writers, editors, artists, and agents faithfully followed the old adage: eat, drink, and be merry.

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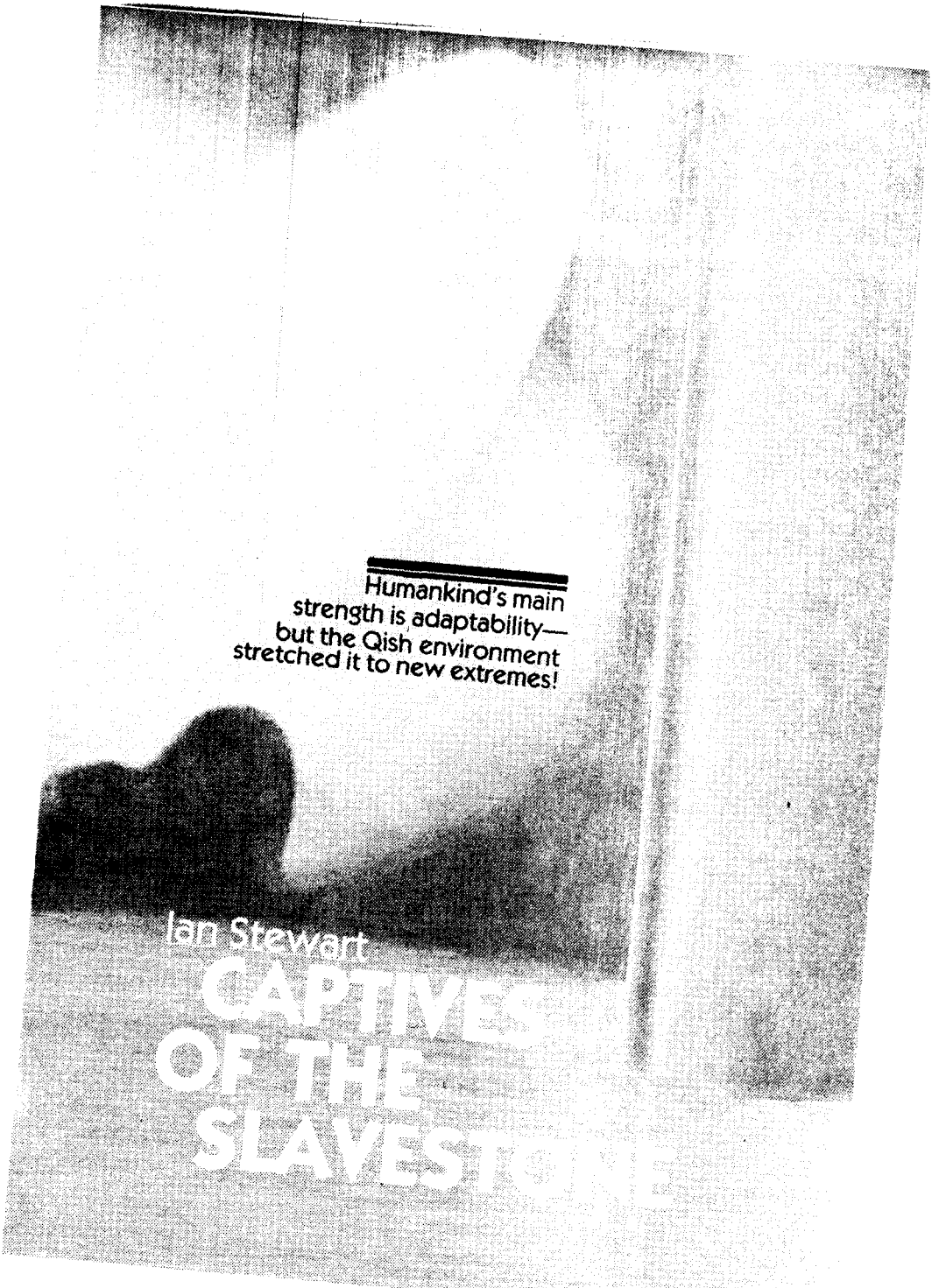
Humankind's main strength is adaptability— but the Qish environment stretched it to new extremes!
Ian Stewart
CAPTIVES OF THE SLAVESTONE

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The room was huge, the furnishings luxurious. A striking woman in a blood-red robe was holding a discussion through an *olosynte*, a type of plant specially bred by the syncurists for long-distance sound-and-vision communication. Her hair was piled on her head in a tall cone. Unbraided, it would have hung to her ankles. Ordinarily Drusilla Sybilschild of Raven's Tooth left the haggling to subordinates, but, as Primarch of the Vain Vaimoksi, she preferred to deal directly with her most sensitive—and profitable—customers.

"Two score quarriers, male, in sound health, for the sulphur mines. To be delivered within the week as requested. Specialist items: twin virgin boys, of outstanding beauty . . . I think you will not be disappointed. I have selected them myself, from one of the most noble families in Vervant . . . their acquisition is being arranged, I anticipate no problems. The price? Ah, for such choice delicacies I must ask a dozen egg-emeralds. . . . The Husler of Dwyle may wish to outbid you. . . . Very well, ten, but you must also take three Swelt serving-maids at two gold rings apiece . . . Excellent. Hale and Free be Yours, Advocate. Strabyen."

She closed the olosynte and yawned. Pleased to have offloaded those three Sweltish sluts at a profit. A bead of sweat trickled down the side of her face—the air was getting humid. She summoned a house-slave to close the weathersynte to the wetlands, and open the one on the cliffs at Funambus Head. A cool sea-breeze began to blow. The smell of salt spray and the cries of ten thousand gulls filled the room.

She still felt sticky. Removing her robe she stooped, naked, through a low opening in one corner. She emerged beneath an underground waterfall two hundred and seventy miles to the south, in a cave whose entrance was now blocked. Bathed, she returned to the palace and walked a few paces to the sunroom. Here the rays of the afternoon sun, from a dozen desert sites around the planet, warmed her body dry.

On the advanced worlds of the Concordat these would be miracles.

On Qish they are commonplace.

A hundred million years before Old Earth devised the dinosaur, a Qishite plant came up with a gimmick that changed evolution into revolution. Like many a plant before it, it reproduced by budding. But *these* buds stayed linked to Mama by a tame wormhole in space. All the descendants of that vegetable Einstein have the trick woven into their genes. Wormholes have two ends, and each end has two sides—inside and outside. The insides join the plants together. The outsides form a spatial short circuit—a vegetable matter-transmitter. The locals call it a *synte*.

Syntei can beat distance, but not gravity. Sideways is easy, down dangerous, and up impossible. Within the wormhole any difference in gravitational potential is compressed. Going up is like penetrating a force-field. Going down risks being torn to shreds by tidal stresses.

When the colony vessel *Magog* went off course and crashed a thousand years back, the would-be colonists had a hard time surviving. With their technology falling apart, and isolated from the Concordat, they survived by adapting to a synteric world. The olosynte is the

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Qishite version of a video-phone. But it is bred by syntelics, not built by technologists. On a planet where matter-transmitters grow on trees, life is —different. Qish is a mad juxtaposition of the primitive and the impossible.

Primarch Drusilla was rich and powerful. Rich enough to own a multi-location palace, and powerful enough to keep it—as befitted the leader of the most feared organization on the planet. Refreshed and relaxed, she resumed her robes and spoke into a *falasynte*—a Qishite telephone. "Instruct the ledger-keepers to prepare reports on our control of the alcohol trade in Larby and the opium supplies in Scythery. Bring me the summaries of our slave-holdings in Treece and North Vargoon. Have Elenya Ingridschild call a meeting of the Seconds to discuss progress towards monopoly control. And instruct the procurement office to acquire the twin sons of the Archlaird of Garraway. Yes, by persuasion, not purchase."

The worlds of the Concordat knew nothing of Qish. But six of their inhabitants did. They had rediscovered it when their starship *Valkyrie* repeated *Magog*'s error.

Tinka Laurel, bouncy brunette—pilot.

Jane Bytinksy, quiet, more of a thinker—xenologist.

Felix Wylde, with a beard to match his name and a silver streak in his hair—solitronicist.

Samuel Grey Deer Wasumi, (permanently) shaven with a single lopsided flame-red pigtail, slightly lighter-skinned than the others—navigator.

The remaining two crew-members had been left behind in the Holy City of Two Mountains on the continent of Shaaluy. The Lady Elzabet of Quynt was suffering from a particularly nasty type of parasitic plant, known as a vunbugula, whose fruit concealed a stone that implanted itself into the stomach wall of any creature unwary enough to consume it. While their mathematical engineer Marco Bianchi took care of her, Sam and the others had made their way back to find the original vunbugula tree—and burn it. The only way, so the syncurist had told them, to cure the infestation. Now Elza was recovering fast.

What they really wanted was to get away from Qish. And to do that, they had to find the rescue beacon.

A colony must be independent to survive. Concordat practice, when sending out a colony-vessel, is to encourage that independence by cutting off all communication. But a rescue beacon is landed automatically on the far side of the planet. By the time the colonists reach it, their independence is sufficiently established for it to be safe to restore contact. That's the theory, but it assumes the colony-vessel arrives in one piece. If the descendants of *Magog*'s passengers had ever found the beacon, they had long before forgotten what it was.

But the crew of the *Valkyrie* knew exactly what it was, and *where* it was; and they had every reason to expect it to be intact. It was on Wevory, not Shaaluy, and the only problem was to get there. On a planet littered with matter-transmitters that ought to have been easy, but it wasn't. The Church of the Undivided Body held Shaaluy in an unbreakable fundamentalist grip, consid-

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ering itself to be an oasis of virtue in a desert of perversion. It controlled the intercontinental *wyzands*. And the starfolk were much too valuable for Deacon DeLameter, the ecclesiarch of the Church, to risk their loss.

So, when they set out to burn the vunbugula tree, they were guided and accompanied by a troop of the Deacon's Personal Guard, under the command of a bald muscular flamen named Jawaharlal Megiddo Ataulfo Kurpershoek. In Two Mountains, the length of a name indicated its bearer's prestige. Most of their possessions had remained at Two Mountains, except their jewelry: a bracelet each, and a ruby medallion round Jane's neck. These objects were not as harmless as they seemed. The bracelets were wristcomps: soft featureless bands as thin as fine leather. Voice-activated and powered by body energy, they were rooted in the flesh and could not be taken off. The medallion, complete with inscription, functioned as a small but powerful laser. The Deacon and his men knew nothing of this.

They threaded a half-dozen syntei, exchanging the desert in turn for a forest, a grassy plain, an island in the middle of a mudflat, and a strange cratered region that reeked of sulphur. From the erratic way the sun had moved in the sky, their path was far from straight. But, on Qish, what looks straight on a map is seldom the most direct route. Now they were on a riverbank, approaching the town of Sackbayne.

It was not a large town. A few rough wooden buildings bordered the pathways. The wood appeared to be hand-sawn into irregular planks, assembled with some skill and secured with tapered dowels in neatly drilled holes. The cracks were caulked with a resinous bark. Several buildings possessed verandahs: to one a dog was tethered, to another what looked like a pink sheep. Most were thatched with reeds in simple, bold patterns. One building sported a square tower with a lapped pyramidal roof, a weathervane, and a symbol of a braided circle over the door. The town temple. A cat curled asleep on the temple steps saw them approaching and took fright. It fled in all directions, the head going one way and the body another. The tail sought independent shelter behind a bush. The separate pieces had their own spider-like legs. It wasn't a cat, Tinka realized; it was a synteric symbiotic colony-creature.

It was also distinctly unnerving.

"Cuzak!" The flamen called to his adjutant, a thin, lanky man with the sad expression of a bloodhound. "Station your men in the square while I talk to the Priest." He moved towards an elderly man in brown robes who stood by the temple steps.

Shortly, he returned, and immediately went into a worried huddle with Cuzak and one of the sergeants. After a brief discussion Cuzak approached Felix. "Sab, there may be a problem. The Priest has heard rumours of a Vain Vaimoksi raiding-party."

"Vain Vaimoksi, Cuzak? What are they?"

"Little of substance is known, Sab. Where they come from, only the Vaimoksi themselves know. They trade in human lives, taking slaves by force and selling them for profit." He spat on the ground. "Some slaves they keep to

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work for them, distilling spirits and cultivating *kreesh*. These substances they also sell." From Cuzak's description, *kreesh* was opium. "But there is a reason above all why men fear the Vain Vaimoksi, Sab. It is the slavestone."

"Slavestone?"

"A synteric parasite, Sab. It sends out tendrils into the victim's stomach wall. The Vain Vaimoksi feed it to their captives and listen through it. And if they do not like what they hear, they shoot a poisoned arrow through it. It cannot be removed by force, for the tendrils remain and fester. That is a worse death. Like the seeds of the vunbugula, it can be destroyed only by killing the mother-plant. And since no man knows where the Vaimoksi monitoring-center may lie, that is no option.

"For this reason the Law is that an enstoned slave, when discovered, is killed."

On leaving Sackbayne they proceeded with greater caution than on their arrival. Presumably even an armed party was not safe from the Vain Vaimoksi. The sun sank behind a stand of thornbark and they made camp. Tinka watched Kurpershoek reach into his mufflebag for the falsynte through which he reported each evening to Two Mountains. He put it close to a bright part of the campfire, and waited for someone to notice the light. Through its translucent membrane she could see a confused room with junior priests rushing in and out, hanging and replacing syntei on great racks, and sometimes talking or shouting into them in a hubbub that made the membrane buzz.

As Kurpershoek began his report, he was interrupted by a flow of words too fast to follow. He motioned the offworlders away. They watched from a distance as his back grew rigid and his face hardened into a cold mask. He spoke to his men. Before they knew it the four starfolk were standing, hands bound, in front of him.

"Perverts!"

"But, Kurpershoek, what have we—"

"Silence! Address me with respect, and only when you are ordered to speak! Your accomplices have been detected in abominations. You are to be brought under guard to Two Mountains. Alive. I have no instructions regarding your comfort." He turned to instruct his adjutant. "Cuzak: the prisoners' heads and bodies will be shaved at the next town. Tie them to the trees!" The guards hastened to obey, and Kurpershoek turned away to the fire where he sat, brooding.

Resigning herself to a cold, hungry, vertical night, Tinka whispered to Felix on the nearest tree. "I suppose Marco got up to something?" He responded with a glum nod. The Church had a horror of what it called "body-division"—passing part of a body through a synte for purposes other than transport. Notably sexual uses. The penalties were atrocious. But there was little point in speculating, yet, on what had happened.

Tinka woke from the doze allowed at last, after the bitter cold before dawn's early sunlight, to realize that he had slapped her face. The pain faded, replaced by the renewed ache of the ropes.

"Who sent you? Whom did they tell you to contact?"

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"No one sent us, Sab. We fell by accident from the—"

"Silence! I will hear none of these lies! The stars are clean, *clean!* You were sent by divisive and abominable blasphemers beyond the ocean! Who are their agents in Two Mountains?"

"Nobody—I mean, we weren't—Sab, we have no knowledge of lands beyond the ocean!"

"Then who has taken your accomplices into hiding?"

She rallied at this unintended fragment of solid information. Elza and Marco had escaped. "Sab, I swear—"

"Blasphemer! Body-divider!" She shut her eyes for another blow, but he muttered in disgust and turned to Felix. He fared no better there, nor with the other two starfolk, and obviously felt diminished by it.

The guardsmen half-hobbled the starfolk's ponies, to prevent escape, and they struck camp. Tinka's pony stumbled at every bump in the track, and she felt sorry for the discomfort they had inflicted on the innocent creature. Ahead the path wound into a narrow cleft between black rocks. The way did not look smoother.

As they approached the cleft, a flight of birds whirred up from the jumbled rocks to her right. Looking up she saw that they were not birds, but wide, spinning disks. Expertly thrown, like a frisbee, the first stopped dead above her head and dropped. She fell headfirst into it, slammed through the jolt of a compressed thirty-foot fall, and splashed into bitter water.

Small hands grabbed her as she came to the surface, and she coughed out a throatful of burning water on a shelf of rock. She heard Sam cursing. When her eyes cleared, she could see no sign of Kurpershoek, but Cuzak and four of his men were lying on the beach. Their hands had already been tied by seven young women in dark red trousers and tunics, who were now hobbling their legs. Tinka looked up at the nearest, to thank her for an unexpected rescue.

The woman came and hobbled hers.

Soon all nine were roped in a line, shuffling towards a cave visible thirty yards from the lake. She was just behind Cuzak. "Who are these people? Where are they taking us?"

He turned round and spat. "Probably they serve the same masters as you. There is some sleight in your captivity. But if you are truly asking, *starwoman*, know that we are captives of the Vain Vaimoksi."

Primarch Drusilla cast her eyes over the latest acquisitions list, and an item caught her attention. What had Elenya Ingridschild been prattling about the other evening? Beings from above the sky? Rumors, rumors. She paced the carpet of her inner chamber, weighing rumor against fact. She reread the report. The new slaves were indeed distinctive, though they were four rather than the six—or eight, or forty, it depended on the source—of which the rumors told. Never before had the records listed such a combination of height and dark skin. That tall, well-muscled one with the silver streak in his cropped black hair must really be *quite* remarkable. . . . And, almost as much as their bodies, the description of their manner intrigued her. Somehow . . . otherworldly.

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Sky-devils? Fallen Angels? Cloud-riders? Pah! Simple tales for simpletons. But, to judge from the report, their appearance must be striking. They would make ideal specialty items, with no shortage of buyers. However, there was no great hurry. Strangers of such bearing might be privy to powerful secrets in their own lands. But information extracted under duress from a healthy and vigorous personality could seldom be trusted.

They must be softened up first. A few months in the fields would be perfect. And something a little more special for Silver-streak . . .

A brutal jerk on the rope shook Tinka awake, and two crimson-clad young women dragged her to her feet.

"You. Come with us. Now."

"But—what—I—"

"Be silent!" A kick. Tinka complied.

Hobbled in line astern, the four starfolk and five guardsmen were led to a small compound set aside from the main buildings, and brought before a hard-faced woman whose robes were edged with blue. She was flanked by three younger Vaimoksi. One held a scroll and pen, the second a falasynte, and the third had spread a cloth on a moss-covered stone. Laid out on it, in a row, were ten wrinkled objects, like prunes. Nearby was tethered a creature resembling a bow-legged goat. There was a stout post, with ropes. Branding irons glowed ominously in a brazier.

The prisoners were arranged in line, Cuzak first. The elder woman inspected him closely, then had him bound to the post. One of her subordinates took up a branding-iron. There was a sizzle and a scream as red-hot metal touched flesh. Cuzak shuddered. Neatly seared into his shoulder was what looked like an eight-digit number in some obscure symbolism. One by one his men fared likewise.

Then it was Tinka's turn.

This time the woman's inspection took longer, and was more intimate. She seemed hesitant. Picking up the falasynte she began to converse in low tones. *Oh, for Mother's sake*, thought Tinka, *get on with it! The waiting is worse*. Apparently satisfied, the woman had her tied facing the post. Her clothing was pulled aside to bare the shoulder. She braced herself for the contact.

When it came, it tickled.

They had painted the number on.

They did the same to Jane, Sam, and Felix. *Don't want to damage the goods*, she realized. *We're selected for special treatment*.

The procedure went to its next stage. Soon it was Tinka's turn. The elder woman pointed at her. "You! What name bear you?"

"Irenotincala Jenifa MacDonald Laurel," said Tinka, adding in her mother's names as well in the hope that a long name would impress her captor.

"Lorel," said the woman. One of her aides noted this on her pad. While two more held Tinka's arms the aide selected one of the prunes. Another murmured into the falasynte. Tinka's mouth was forced open and the prune pushed to the back of her throat.

"Swallow!" A knife touched her neck.

Tinka swallowed.

Felix, last in line, was wondering why there were ten prunes but only nine

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prisoners. He soon found out. The extra one was for the goat.

"You are to learn a lesson," said the woman. "You are slaves. Slaves are property. Property has no will of its own. It obeys . . . or it is destroyed. *You* will obey. The slavestones enforce obedience.

"Observe the glossep," she said, pointing to the goat. Its handler released the noose from its neck and slapped it hard on the rump. The creature bolted.

It had gone less than a hundred yards when it suddenly collapsed in a cloud of dust. It kicked briefly, and was still. The young woman retrieved it and flung it at Sam's feet. A barbed rod, like an arrow, was protruding from the glossep's belly. Barb outwards.

"Such is the power of the slavestone," said the woman. "Do not imagine that your body will pass it. It grows hooks that attach it to the lining of your stomach. Nor can it be removed by surgery, so deep does it bite. You are forever no more than a finger's breadth from death. The slavestone controls you. Absolutely."

Jane repressed a shudder with a visible effort. Sam gritted his teeth. Tinka felt sick. They'd *never* get away. Only Felix showed no reaction.

The woman raised her hand. "Take them to the cane-fields. Instruct them in their duties. Except the one named 'Wild.' He is to be sent before the Primarch."

Their hut was a ramshackle affair of mud and matted reeds, but compared to the cane fields it was heaven. Tinka collapsed in a heap and sat staring at her torn and bloody hands, close to tears. Sam sat heavily next to her and put a comforting arm around her shoulders. Jane watched them in silence.

"Haven't these stupid people heard of *ploughs?*" said Tinka.

"Slaves are cheaper than horses, Tinka," said Jane. "You don't have to look after slaves."

"That's poor economics," said Sam.

"Not if you enjoy the lure of the hunt," said Jane. "Elasticity of supply. There's no lack of enslaveable humans. It's a throwaway society."

"Well, I don't want to end up on the scrapheap," said Tinka.

"Me neither," said Sam. "I wonder where Felix is?"

"In the lap of the Mother of Galaxies." Which wasn't quite accurate. At that moment, Primarch Drusilla was in Felix's lap. It had been made clear to him that, as a bed-slave, he had no choice in the matter. In fact, though Drusilla was a shade heavy around the hindquarters, and ten years more mature than Felix's taste, things could have been a lot worse. Or so he told himself as mentally he lay back and thought of Starhome.

Drusilla ran a hand through his hair. "The two dark women: are you theirs?" Felix had no wish to explain the somewhat liberal customs of his homeworld, and the complex half-casual half-deep relationships between the crew of the *Valkyrie*. "No," he said. "They mean nothing special to me."

"Good," she told him. "Now just place your hand a little lower, *here*." He did so and she snuggled closer.

"Poor Felix," said Jane. "I hope they're not treating him too badly." The others looked glum and she sought to

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change the subject. "Do you have any idea what that enforced five-minute silence this morning was all about?"

"No. The other slaves seemed used to it. They didn't look very happy, though."

"They never do. They just look dull. They've given up hope."

"There's always hope," said Jane.

"I'd prefer something more tangible."

Jane hesitated. She could *give* them something more tangible. And a morale boost right now was more important than security.

They had learned—the hard way—to speak either Standard (the language of the Concordat and of the Qishite nobility) or Kalingo (the dialect of the common folk). Sam's stomach still ached from their one and only attempt to converse in other tongues. But the monitors could only *listen* through their stones, not *see*, and the ground was sandy.

She put a finger to her lips. With another she traced on the ground: *I still have the laser medallion.*

Sam and Tinka sat bolt upright. Tinka scuffed the sand smooth and wrote: *Where did you hide it?* They had been thoroughly searched.

I swallowed it. Now it is somewhere safe.

Where?

She told them where it was buried, at the edge of the cane fields. It would have been safer if only she knew, except that any of them might be killed at any moment. The laser alone wouldn't let them escape, though. To do that they must first rid themselves of the slavestones. But it did give them an advantage. If they kept their eyes open, someone might think of a plan.

We must observe, Jane wrote.

Observe what?

Everything.

By watching, talking to other slaves, and collating their information, they slowly put together the layout of their surroundings. They were on a high plateau, which to east and south fell away to steep cliffs and desert. In the other two directions it seemed to stretch forever, flat and featureless, though there were snowcapped peaks in the far haze. To the west were plantations, worked by slaves. The slave compound, a squalid huddle of huts, was near the southern cliff. To its north was a broad, shallow lake. East of the slave compound were some more solid buildings, mostly storehouses. At the eastern extremity was a massive tower of crumbling stone, rising from jagged ruins. Next to the tower was a blacksmith's shop, in which an elderly slave fashioned shackles for his fellows.

Nobody knew where the Vain Vaimoksi were. They might have been a continent away. The wardens came and went through a series of syntei that connected to a basalt pillar rising beside the southern cliff. From the pillar they disappeared into another syntei. Gangers and beaters, lower in the VV oligarchy, inhabited solid wooden huts north-east of the compound. Syntei within the huts connected to the basalt pillar.

The syntei and the huts were lightly guarded. Most other areas were not guarded at all—the slaves knew that resistance was hopeless. Except for the tower, where the guard was heavy. No-

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body knew why. There was nothing up there.

The more Jane thought about it, the more she realized that conventional fortifications were irrelevant. If the place were to be attacked, the Vain Vaimoksi would retreat through their syntei and raise its other end, creating an impassable gravity barrier. They had little to fear from their enstoned slaves.

Yet such over-reliance on syntei for defence was a potential weakness.

How to exploit it?

The slavestone monitoring center was the key. Destroy that, and you could start a revolt. If you could find it. But who knew what kind of reinforcements they might summon? A revolt could prove short-lived.

She listed the objectives in her mind.

1. Destroy the monitoring center.
2. Start a revolt as a diversion.
3. Get away.

Now, instead of one insuperable task she had three slightly less insuperable ones. Her instructors at the academy would have called it "top-down analysis." It was progress, of a kind.

Next, she listed their strengths.

1. The laser medallion.
2. Advanced thought-patterns, alien to Qishite mentality.
3. Organizational and analytical ability.

It was getting a bit nebulous . . . better move on to the enemy's weaknesses:

1. Overreliance on syntei.
2. Lack of numbers.
3. Failure to separate the three of us.
4. ?

Hmm. *I wonder where Felix is? Dead? Surely not, they wouldn't waste him. If we could somehow make contact. . . .* Or wait for him to contact them. Add it in anyway:

4. Felix—the enemy within.

Drusilla's pleasure at her new bedslave had put her slightly off guard, and she would have been surprised at how much Felix had learned, by deduction and observation, about her multilocation palace. But she hadn't lost sight of her main objective, to extract anything useful from Felix's mind. After a week's instruction in various entertaining but frivolous practices, her patience was starting to wear thin.

"Silver-streak?"

"Yes, Sabi?"

"Once, when I was just a young girl in a village, I had a mule who liked to eat moondaisies. Whenever I was riding it along a track, it would edge furtively towards the daisy-patches on the banks."

"Sabi, I do not understand."

"You resemble my mule. You are not conducting me where I want to go."

Well, I gained a week, Felix thought. "Sabi?"

"You are a bearer of secrets, Silver-streak. I want them."

"Secrets?"

"That curious bracelet on your wrist, that molds into your flesh. It is not jewelry. What is it?"

"In my country," said Felix warily, "the bracelet is given to celebrate the achievement of adulthood. It has no function."

"So you have said before. But I begin to weary of that explanation."

Time to change the subject. Fast! Felix had been at his wit's end trying to find something that he could tell Dru-

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silla that would be useful enough to satisfy her curiosity. His knowledge of solitronics was too hi-tech to be much use on Qish. It would be virtually impossible to make even simple hardware, like a radio. Theory, also was too refined. But in a slave-culture there is no shortage of manpower, and that changes the realm of the possible.

"Sabi, I am but a humble accountant in my own lands. I cannot believe that I have any knowledge that would interest you. But," he added hastily as she moved towards the punishment-chest, "I am skilled in the maximization of profit."

"Your conversation improves, my mule."

"I know nothing of your commercial dealings—"

"Nor shall you ever!"

"—but I can make some generalized intuitions. You deal in a number of commodities . . . slaves, alcohol, kreesh, I know of. There are doubtless others."

"That is no secret."

"To maximize the profit you must make many decisions, weigh one factor against another. Decide how many slaves to employ in sugar-cane production rather than grain, or in processing kreesh-poppies."

"I use my judgement. It suffices."

"Sabi, your judgement is supreme. I seek merely to extend its influence. A method whereby you can explore, rapidly and easily, a hundred possible divisions of labor. In my country it is known as—"

"Words impress me not."

"It will increase your profit substantially."

"What is required?"

Felix told her.

A day later the two hundred slaves, proficient in figuring, arrived. Felix began to train them. It was difficult to work at first, but they were conditioned to mindless obedience, and that was an advantage.

Within a week he was ready to demonstrate.

"A schoolroom," said Drusilla scathingly, looking at the rows of desks, each occupied by a slave with a slate and chalk. "Can you do no better than this?"

"It resembles a schoolroom, Sabi, that is true," said Felix. "But no ordinary schoolroom. Let us suppose, as a working hypothesis, that you have three sources of alcohol production A, B, and C, two sources D and E of kreesh . . . "

Drusilla watched, baffled, as Felix began to chant. "Add ten percent of column 5 to column 8. . . . Total-boy, run down column 6 and convey your result to the tally-keeper. . . . Column 2, erase your slates. . . . "

The first ever spreadsheet analysis on Qish got under way.

The siren blew.

Sunrise. Time to get up. Tinka staggered to her feet, tried to ignore her aching muscles, and followed Sam out of the hut. They lined up alongside a row of slaves.

A dozen wardens walked along the lines, chanting the slaves' numbers into falasyntei. It was a simple roll-call. And if a slave was found to be missing, the number could be relayed to the monitoring-center, and an arrow dispatched to its mark.

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Jane, standing several rows back, watched carefully, hoping to see a flaw in the procedure. There was none. Idly she glanced at the numbers on the shoulders of the slaves in front. Well, she presumed they were numbers. Marco, whose interest in mathematical engineering extended to its history, would have recognized it as Dunnett octal, dating from the post-Pyramid Depression. The symbols |,—, and 0 were combined to yield the digits 0–7, with a dot for zero, in the form

● | – + ○ ⊕ ⊖ ⊕

Then larger numbers were written in base eight. Jane knew nothing of this—but one feature of the system set her mind racing.

If only they could get in touch with Felix. She must tell the others to warn him to be ready, in case the opportunity arose.

"A bizarre system, Silver-streak," said Drusilla, tickling him playfully. "But—"

"But your profit on the Tagruche hashish deal is up twenty-two percent. Sabi."

"It is. And now the spreadslaves are trained, and *you* know far too much about my business. I shall have to have you strangled."

"Sabi? You jest?"

"As a reward, it shall be painless. Unless . . . "

"Unless?"

"Unless there are other such ideas locked up in that curious mind of yours. Henceforth, Silver-streak, your life depends upon proof that it will be more profitable to me to preserve it."

Felix's heart sank. He hadn't anticipated quite that reaction. He should have. *Do you reward your chair when you sit on it?* But she *had* given him the opening he was looking for.

"Sabi, in my land there is made a device for seeing at a distance."

"We too have olosyntei," she said in disdain.

"But an olosynte can see only where its counterpart is placed," Felix pointed out. "I am thinking of a device that could look down from a height on to enemy ranks and pick out the buttons on a general's tunic."

"We do not deal in warfare."

"Or seek out a comely face from a crowd of harridans."

"For subsequent acquisition! Silver-streak, you have won your life. Provided this . . . this—"

"Telescope, Sabi."

"Provided this tescalope works as you say."

Mother, I hope so, thought Felix. *They seem to have some skill with glass . . .* "Sabi, I will begin at once. I must caution you that it will take some time, it is not easy without trained artisans."

"Just do not *waste* time, Silver-streak, or death may arrive early."

"And there are certain calculations that must be made."

"You are free to make them."

Felix said quietly: "I do not have that skill, Sabi."

What? You dare to play games with *me?*"

Felix fell to his knees. "Sabi, I do not mean that they cannot be made."

"But you cannot."

"No, Sabi. There are two who can."

"Who?"

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Felix went for broke. "Samuel Wasumi and Tinka Laurel."

"Zumi and Lorel? Your companions?"

"Yes, Sabi."

Drusilla glared at him. "Is this just a trick to see your friends?"

"Sabi, if it is a trick then the—uh—escalope will fail, and you will know what to do. I have not the skill, but they do."

Drusilla weighed the argument. "Very well." Felix tried not to betray his triumph. "A messenger will convey the matter to them, and return with the answer."

Oh, Mother, that's no good. Quick! "Sabi, it is a subtle question. There are diagrams, mechanisms—it will require face-to-face discussion."

This time Drusilla took longer to respond. Felix offered up a silent prayer to the Deceitful Maidens.

"One—and only one—will be brought. You have a preference?"

"Either is sufficiently skilled." *Don't push your luck, Felix. And for Mother's sake don't ask for Tinka, she'll be jealous. Please, Br'er Drusilla, please don't fling me in dat brier patch . . .* "Sam is the best."

"But either would suffice?"

"Yes, Sabi."

Drusilla reached for the falasynte. "Have the tall girl, the specialty item with the long hair, brought to me. Now!" She sat back with a smug look on her face and Felix tried to look suitably chastened.

Every morning a gang of slaves with a cart came round to take away those who had died in the night. There were few days when their services weren't needed. It was one of the most unpleasant jobs, used as a punishment for minor infringements. The corpses were taken to a trench, dumped, and covered with a thin layer of soil. Most other refuse also went into the trench.

Jane found the procedure fascinating. What particularly interested her was the fact that no attempt was made to remove the slavestones from their hosts. But the wardens took the corpse's number.

When the sun was at its highest there was an hour long siesta. Even for the slaves: it was too hot for the beaters to bother themselves with controlling them. At siesta time most of the slaves slept. Some, mostly old and garrulous, sat around and talked. Jane listened attentively.

One slave, a lanky youth named Goligo, wanted to show her his scars. At first she took this as some sort of heavy-handed sexual advance, but on the third occasion he offered, she decided that anything was worth it to pass the time.

His back was a mess of puckered burn tissue.

"What happened, Goligo?"

"Working iron was. In smith house is vat fish oil. Use to . . . uh, distemper the metal. Not right, is something same. Kalingo to me is not tongue, sorry Sabi."

"No, go on, I understand."

"Vat falled up, oil runned on fire. Poof! Flames. To me was burn. Very bad. Now I work fields."

"Is there much fish-oil at the smithy?"

"Yaz. Full many pots."

Patience is rewarded. Eventually.

Another grey-bearded slave had been

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inside the monitoring center, to clean it. She listened for hours to his semi-senile reminiscences until the well of information ran dry. The monitoring center—and that was the important item: there was *only* one—resembled the falasynte room at Two Mountains. Racks of syntei, each bearing the corresponding slave's number, and lots of people. From a xenological viewpoint that made sense: the system would have evolved from one with only a small number of slaves, and grown organically rather than rationally, so that now it handled thousands of slaves.

Now . . . suppose a slave did run away. Random monitoring could catch her—or him—if the sounds through the slavestone were wrong. But that could probably be avoided. Assume they don't know about it until the next morning. Is that time enough to have a doctor remove the stone?

Stupid. You *can't* remove the stone. It will kill you. Cuzak had said so.

A missing slave would probably be noticed fast. The gangers kept a close eye on them, except at siesta time. So . . . imagine yourself to be a runaway slave . . . they know you've gone, but they don't know your number . . . So they mount a special roll-call. . . .

No, you idiot. There's an easier way. Just listen, and shoot. Anyone on the run would give themselves away by their breathing alone.

As long as everyone else kept quiet. So *that's* what the five-minute silence was for! She brushed aside the thought that during it, an escaping slave had died, because the first glimmerings of an escape plan of her own were forming. *Information overload.* In a riot, of course, the Vain Vaimoksi would just kill at random. But what about something just as noisy and confusing, but where they would need every able-bodied slave they could get?

It was starting to come together.

When they brought Tinka to Felix she wanted to rush into his arms, but the old hag in the red bathrobe with the laundry-basket hairdo made sure she didn't. "Discuss only the task set you. If asked your welfare, say you are treated kindly. Complete your task before evening: there will be no second meeting." She didn't have to ask the penalty for disobedience.

What had happened to Felix? Was he collaborating with the slavers? He was formal and distant. But she could hardly expect otherwise, in those conditions. She began to feel better when Felix explained to her the optical calculations that he wanted. Basic school physics —any of the starfolk could have done them. Though why he kept calling the device a "tescalope" was beyond her. *Patience. He must be up to something. Wait for an opening.*

Half an hour passed and the watching wardens relaxed a little. Felix said loudly: "Sabi Laurel, I trust you are being treated as well as I."

"I cannot complain." *Words are two-edged.* "I am treated like royalty. Like—a Countess. The Countess of Monte Cristo."

Yes, thought Felix, who had also read the classics. *We all want to escape.* "Me too."

Tinka tapped a finger at his sketch of the telescope design. "There is need of improvement, Sab Wylde. In particular

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the state of the servos must be modified."

Servos? This isn't a robot, what's she—oh. Servos: slaves.

"The servos must be adapted to higher revs. The design is difficult, but I can supply it. The timing will be unpredictable." Or, in plain Standard: *a slave revolution must be brought about; I can do it; I don't know when.*

"I am alert to that possibility, Sabi Laurel," said Felix. "Perhaps I can assist with the arithmetic?"

Tinka took up a quill and began to sketch. A warden moved closer and watched over her shoulder to make sure she wasn't writing any messages. She drew a series of lenses and tubes that made no optical sense. "This is a preliminary sketch, Sab Wylde. It is purely topological." She pointed to one end. "Here we have the input: an eyepiece of *Valkyrie* type." She wrote the letter "I". "And in the middle we have a Snowjob universal collimator." This time she wrote "U". "Finally, at this end, the *main objective*."

"Let me see if I've got that. That's U, this is I, and here's the main objective . . . pointing into the wide blue yonder."

"No, that's U, and *this* is I. But you're correct about the objective." Tinka warmed to the task. Once you've established a private language, everything gets easy. "Now, the problem is to create a free light-path between 'I' and the objective. That's where 'U' comes in, understand?"

"I follow the principle, but I'm not sure whether I have the facilities."

"I imagine that the Primarch Drusilla can be persuaded to supply them," said Tinka drily.

"The Primarch has been most helpful to me and I will put the matter to her most vigorously. . . . But first, I must obtain the necessary instruments." *No weapons, Tinka.*

"You must improvise. Grind this prism to make the image as sharp as possible." *A glass knife?*

"I will put my mind to it." The wardens were taking too great an interest and Felix went off into a long discussion of equivariant oscillatory integrals and spherical aberration until they became bored. Then he asked his last question.

"We must define more clearly the timing of the servo revs."

"Unfortunately that is not possible with the existing resources. But the marks should be clear to you. I leave it to your judgement."

When the revolt happens, it should be obvious. After that, it's up to you.

During the siesta, Jane had taken to sitting on the banks of the lake. The free-floating lily-pads were ring-shaped, with a central hole occupying most of their area; and you didn't have to be a genius to work out that they were an aquatic species of synte. The froglike creatures that hopped in and out of them used them as rights-of-way.

Near the shore the lily-pads were no more than a few inches across, but further out—beyond her reach—they grew to half a yard. She smuggled a small one back to their hut but it disintegrated when it dried out. The wardens took no interest in the plants—presumably they considered them harmless. A synte that led nowhere was little use to a slave,

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and anyway, the slavestones gave total control.

Absolute power breeds absolute complacency.

Sam sat down beside her. Eventually she emerged from her reverie and noticed him.

"Sam?"

"Yes, Jane?"

"Do you remember that ceremony thing that Sadruddin told us about? The one where one synte is passed through another—"

"The Celebration of Knotted Space. In the misty season. One half of an oval *brasure* is passed into its counterpart—"

"And emerges from itself. That's the one!"

"Yes. It symbolizes the tying of the bands against sin, and rebirth of the year from its own—"

Jane let him drone on, while she remembered. Marco had started out thinking that syntei that swallowed themselves would disappear, and then bored the pants off everyone explaining why the index theorem meant that it couldn't. Hmmmm. *A synte can pass through another synte.* But will it still work, afterwards?"

Later she experimented with several lily-pads of different sizes. *Ni porbleem.*

For several days she studied the frog-like creatures. When she threw them a lump of bread, they would chase it, gulp it down, and hurry back for a second course. Ranarian retrievers.

The lily-pads were flexible, and could be rolled up into a tube. Unrolled, they continued to function—provided they didn't dry out. They were naturally springy and wouldn't stay rolled of their own accord. One more piece of the puzzle clicked into place.

That evening Jane unraveled the bottom inch of her woollen shift and, using two sticks, started knitting.

"That's a bit small, even for a sweatband," said Sam.

"That's because it isn't," said Jane primly, and carried on knitting.

"What is it, then?"

"A frog-collar."

Sam laughed. "You're obsessed with those frogs."

"Every damsel in distress must have her handsome frog to kiss her and turn her into a princess."

"That doesn't sound right," said Sam.

"I call my frog Rapunzel," said Jane.

Sam had no answer to that.

I have a plan, Jane scrawled in the sand. *To escape.* It took two hours for her to explain the details to the others' satisfaction. *I only hope Felix does his bit.*

And I need a volunteer.

For what, wrote Sam.

Jane told him.

Cecily Sarahschild of Larkspine Tributary screeched in pain. That damned fool slave had dropped his digging stick on her toe. She ordered him a mild flogging, with a sting in the tail.

When they locked Sam in the pen with the burial cart he knew he'd succeeded. The severity of the offence had been carefully judged. Once the burial detail was over he'd be returned to the fields.

The ganger kicked him awake as the sun rose. With the help of two other

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slaves, he began pulling the cart round the compound. There were two corpses that morning, about average. While they were loading the second one the wheel of the cart collapsed. During the ensuing confusion it was the work of a moment for Sam to modify the number branded on one of the corpses, using the laser medallion which he had taken from its hiding place and concealed in his kilt. As Jane had noticed, in the Vain Vaimoksi's number symbolism many digits closely resembled each other, making changes easy. Marco would have pointed out that of the 16,777,216 eight-digit numbers possible in Dunnett octal, only one—the number ⊕⊕⊕⊕⊕⊕⊕⊕ = 16,777,215, could *not* be so modified. Marco was the human equivalent of piles.

Eventually the wheel that Sam had loosened was replaced, and they began to drag the cart to the burial trench.

The warden noted down the number of every corpse as it was thrown in. Jane had deduced—it was a guess, but a good one—that the corresponding synte would be removed from the monitoring center. Destroyed, most likely, because the slavestone connection worked both ways, and it wouldn't do for a functioning stone to get into the wrong hands. Sam tried not to hold his breath as the warden examined the modified corpse. There were two places where the plan could fall apart. The warden might notice if Sam's handiwork didn't match the original brand; and the new number might not be in use.

But she gave the brand only a passing glance, and the number passed scrutiny. Somewhere on Qish a slave would soon be losing his stone—and never know it.

Sam and his companions began to dispose of the corpses.

At the edge of the trench Sam dropped his end of the "modified" corpse, apparently out of fatigue. Cecily Sarahschild raised her beater threateningly, and Sam staggered to his feet. When the corpse tipped over the edge into the foulness beneath, he slipped and fell with it, screeching. Cecily laughed, but she went off with the other two slaves to get a rope.

As soon as she'd gone, Sam set the laser to "scalpel," and cut a deep incision in the abdomen of the fresh corpse. He reached in a hand and felt around inside the stomach. Its contents were no worse than those of the pit. Carefully he dislodged the slavestone from the abdominal wall and replaced it, with the laser, in his kilt.

When they hauled him out he smelt so bad they threw him in the lake. He hid the laser and the slavestone under a rock by the bank, ready for Tinka when she needed them.

Jane squatted by the lake, feeding bread to her frog, resplendent in its woollen collar. She unraveled a thread. "Rapunzel, Rapunzel, let down your hair." She threw a lump of bread out among the largest lily-pads.

Rapunzel headed for the food, letting its "hair"—the woollen strands of the collar—unravel behind it. It hopped in through one lily-synte and out through its counterpart, grabbed the bread, and headed for shore.

Jane waited until the frog arrived, and began to reel in the pair of syntei threaded by the wool.

The frog deserved a kiss.

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But it would probably prefer more bread.

"Fire!" yelled the warden in charge of the sugar-cane warehouse. "Bring slaves and water! Fire! Fire!" She was close to panic. Losing a year's crop, and the comcomitant revenue, was a capital offence.

Tinka Laurel smiled grimly to herself, slipped the laser medallion back beneath her shift, and moved away to the next task.

In silence, Tinka and Jane crept up on the tower. Behind them, flames shot skywards from the sugar warehouse, and thousands of slaves, beaters, wardens, and gangers rushed around in creative confusion, using syntei to spray water on the burning wreckage. The noise was appalling, just as planned.

Sam was waiting to start the revolt.

Jane carried the slavestone, retrieved from its lakeside hiding place, and the pair of lily-syntei, wrapped in a damp cloth.

Tinka carried the laser. The wardens guarding the tower never stood a chance.

They removed a barrel of fish-oil from the smithy, and began to haul it up the tower. It was heavy work, and the seven-legged spider-creatures the size of rats hardly helped, but Sam couldn't be there: he had more important work to do. Jane had no idea how much height they would need, but the top of the tower was the highest point around and the heavy guard wasn't there just for fun. It *had* to be because it was the only place higher than the monitoring-center. Nothing else made sense. On Qish, height is *the* strategic factor: lots of things can go down a synte but precious few can fight their way up through the compressed gravity-barrier. Now, use the laser to boil up some oil, and then . . .

Usually Maggi Annaschild hated monitor-duty. It was boring. But for once she'd have preferred boredom. Today it was pandemonium. With all the noise of the firefighting, the syntebanks were an earsplitting babble. No doubt a few opportunists were sneaking away under cover of the noise. They'd never learn. Tomorrow, when it had all died down, the archers would disabuse them . . .

Amid the chaos, she didn't notice a thin tube being pushed through one of the slavestone syntei. It landed at her feet and unrolled. A much larger tube, of copper rather than vegetation, pushed through it.

Finally, she did notice, when the stream of blazing oil enveloped her. But by then it was a lifetime too late. Along with the banks of slavestones, she and her fellows burned.

Sam felt a sharp pain in his stomach. His slavestone's counterpart was on fire, and some of the heat was getting through. He told himself not to worry. Jane had assured them that the plant would wither and sever the connection before they burnt to death from the inside. He gasped as the pain became almost unbearable. Through a haze of pain a detached corner of his mind debated whether Jane might be wrong . . . but the sensation faded to a dull ache. Recovering, he seized a passing warden by the throat and broke her neck

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with a *hai-ganzai* chop. The remainder of his gang looked on aghast, waiting for the arrow.

Nothing happened.

"Slaves, arise!" yelled Sam. "Overthrow the oppressors!"

The slaves stared at him.

"The slavestones are destroyed!" he yelled. "Did you not feel the burning in your bellies?" He grabbed a well-muscled young man standing near him, mouth open. "Fight, you fool!"

The youth gave him a look of horror and sank to his knees.

"Do you think the Vain Vaimoksi would let me say what I have said, and live? I tell you, the stones are burned! You are free!" The terrified young slave began to gibber incoherently.

Sam cursed slave mentality. He ran to another group, with the same lack of results.

Then he saw a better prospect.

"Cuzak!"

"Stay your distance, abominator!"

"Cuzak, this isn't the time to discuss fine points of morality. Do you want to be free?"

"Does a grumbat want to fly?" said Cuzak, startled into dropping his defenses.

"The slavestones are destroyed! Burnt! You felt the pain in your belly!"

Cuzak was in two minds. But the *first* task was to escape. *Afterwards* was another matter . . . Was it doctrinally sound to aid a blasphemer in order to improve the prospects of his future punishment? With relief he recalled a passage from the litany of Seamus the Cunning, in which Seamus had assisted an idolater with his wood-carving, in order to gain his confidence and ply him with strong drink. While his attention was thus distracted Seamus cast the graven image of the tree god Desiduus into a bath of acid. After which the idolater followed suit. Cuzak gave rapid orders to his men.

Falling into battle-formation, they made short work of three beaters and an elderly ganger.

The trembling youth rose to his feet, his world in turmoil. Sam pushed him at a nearby beater, who stumbled and fell. The youth looked on in horror. She staggered to her feet and lashed at him with her whip. That was a mistake. Expecting death, and not finding it, the youth reacted instinctively to the lash. He grabbed the beater by her hair and flung her to the ground, kicking like a madman. As the other slaves realized that he was still living, they moved to join him. . . .

A bell began to toll, deep, urgent. Drusilla climbed off Felix and ran to the falasynte. "What? But that is impossible! Send in more wardens immediately!"

"Sabi, we are sending them as fast as they can get through the synte, but there is much congestion," came the reply.

"Raise the internal brasures so that none may enter or leave."

"The Palace is already secured, Sabi."

"Inform me of any developments. The revolt must be put down at any cost. Kill them all if you must. We can easily capture replacements."

She turned to face Felix. "Count yourself fortunate to be here. Any slaves that survive this . . . futile attempt . . . will regret the day they were born.

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But I must have you placed under restraint—"

She froze, fear in her eyes.

The knife-edged prism that Felix had fashioned in his laboratory pricked her throat. "Do what I tell you, or you're dead."

"I will kill you for this!"

"I'll do the killing. I want a synte route opened up so that my friends can be brought here. I don't care how you do it; but any tricks, and I'll slit you from ear to ear. Now, move!"

Jane, Tinka and Sam waited at the cliff's edge. Cuzak watched nearby. Something was happening on the basalt pillar—the flow of wardens had ceased and there was a lot of shouting and rushing around. Behind them the fires raged as the freed slaves took revenge on their captors. It was messy and violent.

Then a woman appeared through the synte, with Felix close behind. He was holding something at her throat and shouting at the wardens. The woman spoke and they shrank back.

Jane stood up and waved until Felix saw her.

A warden was dispatched to fetch them. Keeping always in Felix's line of vision, she led them to a synte that connected with the pillar. Cuzak stayed with them. His men were busy roasting their erstwhile captors, but he had no hesitation in leaving them to that pleasure.

Cuzak was after bigger game.

With Drusilla as hostage, and the laser medallion to back up their threat, they encountered no resistance on their way to the Primarch's apartments. There were a thousand things to say, but now was not the time. Jane and Felix put their heads together to sort out the next moves. Tinka kept the laser pointed in Drusilla's direction while Sam found a couple of knives in a drawer. He cut himself a sash from the curtain, stuck one knife in his improvised belt, and tossed the other to Cuzak, who had been foraging for food. Then Sam took the laser while Tinka raided closets to find them some better clothing than slave-garb, and rolled it into a bundle, along with the fruit, bread, and goat's cheese that Cuzak had found.

"There are many exits," said Felix. "But most lead to dead ends or bad terrain. Drusilla must know a good escape route. We'll just have to persuade her to tell us."

A demonstration of the laser proved effective. Drusilla led them down a concealed flight of stairs to a damp room of rough stone. An oriel, some two feet across, was suspended by ropes high on one wall. Sam lowered it until the gravity barrier disappeared.

"It may be a trap," said Jane.

"Shove the bitch through first," said Sam.

"That may be what we're expected to do."

"Then we may as well take the risk ourselves," said Sam—and before anyone could prevent him, dived through the synte's mouth.

He was back within seconds. "All clear. It's on a forested slope above a lake. I couldn't see far because the trees get in the way, but it seems uninhabited."

"Let's go," said Felix. "Sam, you go first. Give Jane the laser. Tinka next.

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Then Drusilla. Jane, stay right behind her. I'll follow. Cuzak, you guard our rear." Cuzak didn't look too happy about this idea, and he gripped his knife more tightly, but Felix had other problems on his mind and didn't really notice.

One by one they scrambled through. But as Felix bent to crawl into the synte, a bony hand grabbed his ankle.

"No!" Cuzak yelled. "I see through your plot! You will destroy the synte, and strand me here to die! Abominator!" He slashed at Felix's leg, but Felix rolled to one side and the knife struck rock, throwing up sparks.

From the far end of the synte the others watched, helpless. Felix had the usual starfolk training in *hai ganzai*. Cuzak may have been skinny, but he was quicker, tougher, and more experienced in fighting dirty. They rolled over and over on the floor, making it impossible to use the laser. From behind them came a clatter of feet on the stairs. And a clatter of weapons.

"Jane," said Sam in a flat voice, "get the laser ready to close off the synte."

"But—"

"I *know* Felix is in there. But we may have to do it anyway."

Felix caught Cuzak's arm with a kick and the knife dropped to the floor. Another kick and his legs were free. As Vain Vaimoksi wardens armed with spears and crossbows rushed into the room, Felix flung himself at the aperture. Cuzak, howling in fear and anger, recovered his knife, dived at Felix, and missed. A bolt from a Vaimoksi crossbow hit the rock by his face and ricochetted off. Another struck his leg and he crashed to the floor.

At the far end of the synte, Sam grabbed Felix's arms and pulled. Cuzak, seeing what he thought was his betrayer getting away, roared "Die, blasphemer!" and slashed at the rim of the synte with the knife.

There was a *squelching* sound like a sack of wet sand hitting a stone floor. Felix suddenly came free and Sam toppled backwards, Felix on top of him.

Jane screamed.

Tinka took one look and threw up.

Felix's face was inches from Sam's. It looked wrong. Felix felt wrong. He didn't weigh enough. He—

Sam carefully rolled Felix off him and stood up. But it wasn't Felix.

It was *half* of Felix.

There was hardly any blood. The severed torso, pinched off at waist level, was—*sealed*.

"Oh, Mother of Galaxies," said Sam. "The wormhole collapsed when he was in it."

It was several minutes before any of them noticed that Drusilla had slipped away.

The ground was too hard to dig a grave. They collected rocks and built a cairn around the body, standing around it in saddened silence. Jane was taking Felix's death especially badly.

"Jane," said Sam gently. "We're all shocked. But now isn't the time to grieve. We *must* keep going."

"You don't understand," said Jane, through tears. "I was so proud of myself for thinking up the escape plan, and Felix played his part so well, and then—"

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Sam waited.

"—and then it all fell apart and he's *dead!*"

"But three of us are alive," said Sam. "And free. If we hadn't tried to escape, soon we'd *all* be dead. Or worse."

Jane looked up at him, face stained with grief. "You think I haven't thought of that? He's still dead, and it's still my fault."

It's not your fault, thought Sam. *Felix made a mistake. He didn't take into account what might be going on in Cuzak's mind.* But he could hardly point that out to Jane. Instead, he said "Felix died to save us. We *all* knew there were risks. We were *all* willing to take them. For the group, not for ourselves. Are you going to throw that sacrifice away?"

He put an arm round her shoulders and helped her to her feet.

"I *thought* there was something funny about the lake," said Sam. "But there wasn't time to take a closer look." The synte had placed them in the crater of a volcano. To judge from the heavy reforestation, it had been extinct for a long time. They climbed to the volcano's rim, the crater lake below them. In every direction was ocean.

"Drusilla knew this," said Tinka. "There must have been another synte nearby. This was just a staging-post."

"Possibly. If there *was* another synte nearby, you can bet there isn't one now."

"No. And we'd better get off this island fast, before she turns up with reinforcements. We can use the laser to fell some trees, and build a raft."

* * *

Drusilla stared at the blackened husk of her escape route. *That she-glossep Elenya Ingridschild! She never could accept being just a Second. She acted quickly, I will admit. I didn't think her capable of it. I underestimated her.*

None of which was going to get Drusilla off Vulcan's Anvil.

In the distance she could hear the noise of crashing timber. Later a thin trail of smoke threaded its way skyward from the beach. She moved silently into the bushes, towards the smoke.

Sam sat on a rock, brooding. Felix had made a mistake. Felix had paid for it. Were they making another mistake? They didn't *know* that Drusilla had left the island. If she had, she might be back with an army at any moment. *If* there were other Vaimoksi-controlled syntei. They didn't know that either. They didn't really know much at all, not even where they were, although there was land dimly visible a long way to the west. Maybe fifty miles.

There was a spring about half a mile up the volcano's slope, and they filled a gourd with water. When night fell they ate some of the bread and goat's cheese and sat by the fire on the beach. Nobody felt much like talking. Jane sat on her own, knees hugged to her chest, head bent. Drusilla watched hungrily from the undergrowth. The stars came out, enough light to see by.

Eventually the starfolk rolled themselves in oddments of clothing, and slept. *The fools haven't even placed a guard!* If she could get the knife that the one with the pigitail carried . . .

It was extremely uncomfortable, Sam decided, lying awake and pretending to be asleep. But *if* Drusilla was still on

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the island, and *if* she hadn't been able to get help, she'd be cold and hungry. She could scarcely have missed the smoke from their fire. If he'd posted a guard she would have stayed away.

He barely heard the scuffling sound, but his subconscious recognized danger and he was instantly alert. Either it was a big animal—but no, an animal would make more noise . . . unless it was a hunting animal, which was a thought he wished he hadn't had . . .

Drusilla reached for the knife. A hand grabbed her wrist, and twisted. She fell flat on her face with Sam on top of her yelling blue murder to wake up the others. They tied her hands and feet.

Drusilla's struggles ceased. "Kill me if you will. I fear no slave."

Sam raised the knife, but Tinka clutched at his hand. "There's been enough killing, Sam!" She broke off a piece of bread and offered it to Drusilla, who knocked it aside. Tinka picked it up and offered it again.

Hunger won.

They had chosen to build the raft at a part of the island where a strong current ran in roughly the right direction. By noon the logs had been lashed together with tough vines, the last knots had been tied, and the provisions were loaded and fastened down.

Sam gestured towards Drusilla. "What about her? I say we leave her. Better still, kill her." He reached for the knife.

"No, Sam," said Tinka. "Another death won't bring Felix back. We'll take her with us. We've got to keep an eye on her."

"She's a danger and an extra mouth to feed."

Jane spoke her first words that morning. "Sam, please, not in cold blood." Sam dropped his hand from the hilt. He couldn't bring himself to argue with Jane.

But Drusilla was looking more and more unhappy, and when they tried to load her aboard the raft, she began to struggle and scream like a maniac. They couldn't get any sense out of her, but she was clearly determined not to go with them.

Sam roped several spare logs together, dragged them to the water's edge, and pushed them out to sea, into the current.

"What are you doing, Sam?"

"Dipping my toe in." He would say no more.

The bundle of logs drifted out on the surf, fifty yards, a hundred. Nothing happened. The surface of the sea rose and fell in a rhythmic swell. Nothing disturbed the surface.

"Sam, I don't—"

Jane screamed.

A shapeless mass erupted from the water, and began to *grow*. Holes appeared in its flanks. Tentacles pushed through the holes, thick as tree-trunks, growing rapidly to a frightening length. As they grew, smaller tentacles sprouted from them. The creature began to resemble an insane oak tree.

"Oh, Mother! Just look at that! No wonder the bitch didn't want to come, she *knew!*"

A tentacle reached out, and grabbed the log-bundle. It disappeared into a hole in the monster's side. The hole closed.

"It's *huge!* It's incredible!"

"I think it's got some kind of ex-

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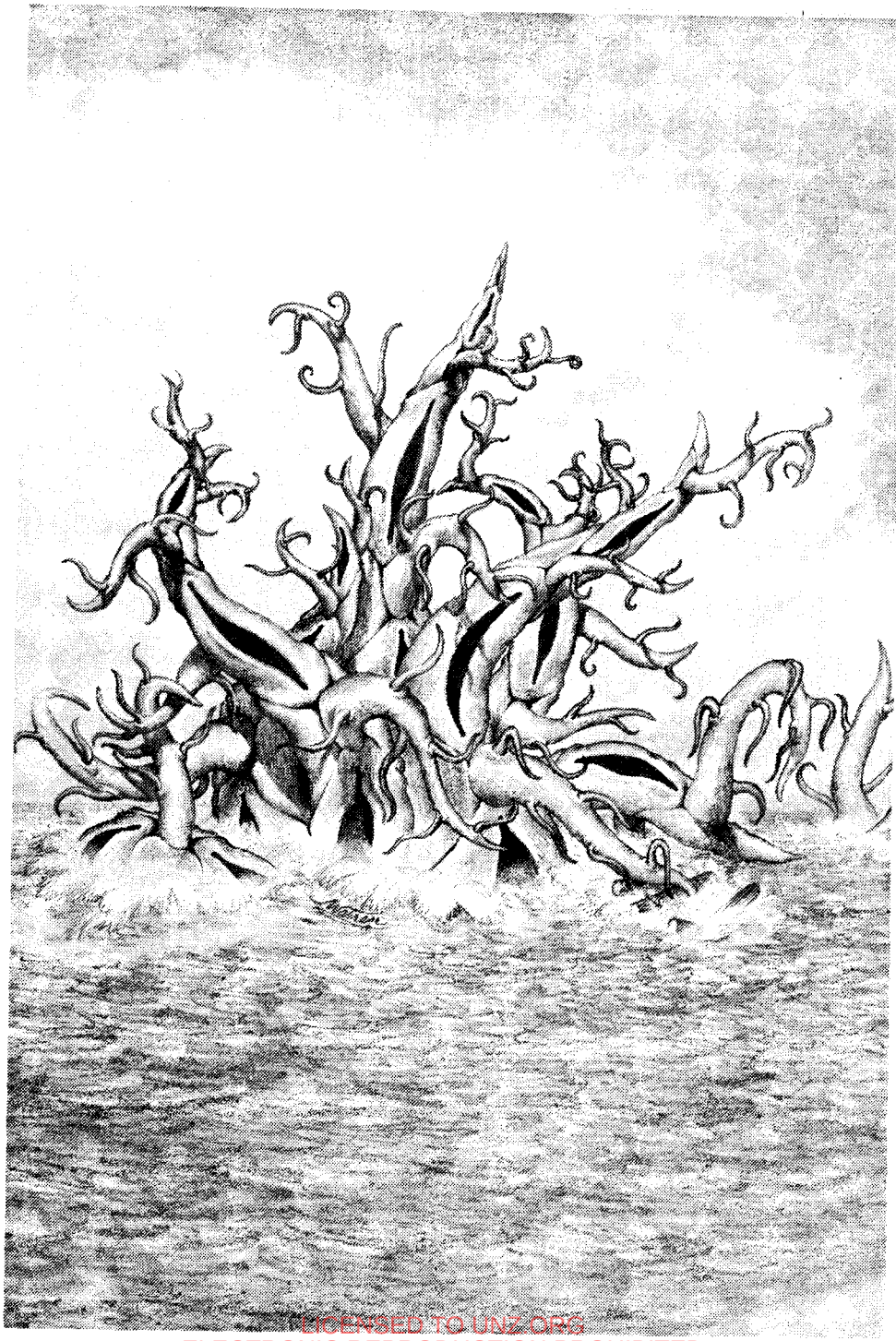

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panding syntei," said Tinka, in an unnaturally matter-of-fact voice. "It puts tentacles out through them, and there are more syntei on the tentacles, and they expand, and—"

The creature abruptly began to writhe as if in a frenzy. There was a shower of spray, and it vanished.

"What happened?" said Sam.

"I think. . . . " said Tinka. Her voice trailed off in awe.

"Think what?"

"I think something *ate* it."

It was the third day. How do you get off an island surrounded by deadly seamonsters?

"If I was going to do it," Sam had said, "I wouldn't start from here." Even the jokes were getting desperate.

Jane sat stony-faced on a rock and stared out to sea. A flock of cormorants—well, they looked like cormorants, except they were yellow and doubtless had violet blood and golden bones like everything else indigenous to Qish—were gliding along the coast in search of fish. A thought struck her.

She began to wish it hadn't.

She didn't want to be the cause of Tinka's death too.

But if . . .

It was all too much. Jane sat on the sand and howled.

"Jane! Jane, what's the matter?" *As if it isn't obvious*, Sam thought. *But what else can you say?* "He's gone, love. I miss him too—"

"I'm not crying for *Felix!*" The vehemence was totally unexpected. "I'm crying for *me!* I don't know what to *do!* I just . . . no, no, not Tinka too, I couldn't bear it!"

Sam placed a hand on her shoulder, but she pushed it away. "Leave me alone, Sam! I don't need your pity!" Then she saw his face, and suddenly pulled his arms about her, burying her face in his chest. A muffled "I'm sorry I'm sorry I'm sorry"—then racking sobs.

As he stroked her hair, she began to calm down. A long time passed.

"I'll . . . I'll be all right now."

"Jane, I—" Sam shook his pigtail in bafflement. "If you don't want to talk about it, stop me. Felix, yes. I understand. But . . . you were talking about Tinka. No harm has come to Tinka."

"Not yet."

Sam waited patiently, until he realized she had no more to say. "Why *should* anything happen to Tinka, Jane?"

"Because—because I'm going to cause it, Sam! Another of my hairbrained—I've already said too much—I won't, I *won't!* Sam, I just don't know what to *do!*"

But before he could pull her close, a voice came from close by.

"A pretty scene."

He whirled. It was Drusilla. Tinka stood in front of her, her face ashen. Drusilla held the laser.

"Tinka! How did she—"

"I untied her legs to take her to the spring for water. She kicked me in the stomach. She must have watched us, she knows how to use the laser. I'm *sorry*, Sam—"

"Quiet, slave! Hold your tongue before I burn it out! Until *you* meddled in my affairs I was Vain Vaimoksi Primarch—ruler of the world!" For a moment the urge to kill them all was irresistible—but the moment passed.

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"A pity, but I must let you live. Three servants is too small, but it will have to do. I promise you this: not a day will pass when you do not curse your ancestors for having caused your existence."

Drusilla set them to work, building a shelter out of leaves and branches. It looked like rain.

That evening she made Jane and Tinka watch while she used the laser to flay the skin from three of Sam's toes. By the time she had finished, Jane had gone into catatonic shock.

Drusilla's actions were capricious and arbitrary. That may have been deliberate, to keep them unsettled, but it looked as if the ex-Primarch was losing control. Which was a terrifying thought. She had allowed Tinka and the injured Sam to join her in the shelter. Outside, in the darkness, Jane sat motionless in the downpour. Drusilla hadn't even bothered to tie her up. Her mind had obviously gone.

Sam and Tinka's wrists and ankles were tied, but Drusilla had freed one of Tinka's hands so that she could tend to Sam's burns, dressing them with strips of clothing. It was difficult, but she was determined not to let her frustration show. Drusilla, enjoying her revenge too much, had found it difficult to stop. Only the hidden ministrations of Sam's wristcomp, monitoring and modifying the chemicals in his bloodstream, had kept his heart from failing.

The thought was too much. "You monster!" Tinka spat. "It's a miracle you didn't kill him! And *then* where will you be, with the strongest of your precious slaves dead?"

"I admire spirit in a slave," said Drusilla. "But I will not permit insolence. Let me just check your knots . . . good, still trussed like a turax." She slapped Tinka's face, three times, hard, crushing her lips against her teeth and drawing blood. "You are right. Three slaves is not enough, and with one going mad . . . I think I will breed you. And the madwoman."

Not unless you learn to change the hormone-blocking programs in our wristcomps, you won't, thought Tinka. It gave her grim satisfaction that in this matter, at least, she might still frustrate Drusilla's wishes.

Sam, sleeping fitfully, groaned. Drusilla checked his bonds, retied Tinka's hands, and composed herself for sleep. Tinka found sleep impossible, and lay trying not to think and listening to the rain on the leaves, until it stopped.

In the morning, Jane had disappeared. Footprints in the wet sand led to the water's edge.

"Now I only have *two* slaves," said Drusilla.

The sun rose higher, while they dug holes in the sand with their bare hands. Drusilla wanted a more solid dwelling. Their feet remained tied. Soon their lips became parched.

Sam collapsed, moaning incoherently.

"He needs water," said Tinka.

"Address me with respect, slave!"

"*Sabi*, he needs water. Without it, he will die."

Drusilla acted out a little charade of giving the matter careful thought. "I am a merciful mistress," she said eventually. "You may both drink water at the spring." She retied their hands and held

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the laser on them while untying their feet. "You will walk in front. Any attempt to escape and I will burn your legs off." They clambered awkwardly up the hill, hampered by Sam's damaged foot. Tinka tried to support him, but Drusilla gestured her away with the laser.

There was no hope at all. Tinka began to envy Jane. But now even suicide was beyond their powers. And when evening came. . . . More toes? Would it be *her* turn? What other torments would that evil mind devise? Tinka cursed her own stupidity. Drusilla may have looked harmless, stripped of her power, but she was as dangerous as a cobra, and ten times as cunning. People like her ought to be strangled at birth. Sam had been right, they should have killed her. Qish was no place for sentiment—

There came a sharp *crack!* and a crunching, liquid sound. Tinka's ears rang, it was so close. She turned.

Drusilla was lying on the ground. Most of her head was missing. The bushes were liberally spattered with blood, dripping stickily from their leaves. A large pool soaked into the ground.

And *something* was crashing towards them through the undergrowth. They were under attack! Tinka had visions of fierce cannibal tribesmen, vicious synteric monsters, demons, ghosts . . . She struggled against her bonds, her legs had turned to water . . .

The bushes parted.

"Tinka! Sam! Are you all right?"

Jane.

She walked slowly over to Drusilla's body. The laser medallion was tangled around one wrist, splashed with blood. Jane freed it and wiped it clean on the corpse's clothing.

Then she fainted.

A subdued trio sat around the fire.

"No," said Jane, "it wasn't an act, Sam." She shuddered. "I went a bit crazy, I think. But just when everything was at its worst, a kind of—*anger*, I suppose—took over. And I finally realized that we'd done what Felix did. It's like a game, in a way. You lose concentration, you make a mistake. But it *isn't* a game, and mistakes kill. It wasn't *my* fault that Felix died—it was his. He lost his concentration and forgot that Cuzak was a frightened man and a religious fanatic. But the next mistake *was* my fault. I stopped you from killing Drusilla. I was wrong. Qish is no place for misplaced mercy. Not for someone who can mastermind an operation like the Vain Vaimoksi. I see that now."

"I made that mistake too," said Tinka. "And I cost you your toes, Sam."

"The skin will grow again. And when we get back to Starhome the medics can pretty me up."

"You really think we will?" said Tinka wistfully.

"I know it," said Sam. But he didn't sound convinced. Jane was steeling herself to drop her bombshell when Tinka broke into her thoughts.

"We thought you'd killed yourself."

"Animal cunning. I told you, I was a bit crazy. The anger took possession. I knew that I was the only person who could save us. So I left a false trail and took to the hills. I can't remember much, not until this morning. By then the madness had passed.

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"There are plenty of syntei in the undergrowth. It was easy to rig one beside the path to the spring. I knew Drusilla would come that way. I hid further up the hill where I could see you coming, covered the other end of the syntei with my skirt to stop the sky shining through, and waited. When she came into the sights I dropped a rock through."

"A synte cannon," said Sam. "Gravity-powered."

"I knew I only had one chance. You'll never know how scared I was when I let go of that rock. One mistake, and we'd all be dead."

The others remained silent.

"So I didn't dare make a mistake." She hugged Sam briefly and kissed Tinka on the cheek. She couldn't put it off any longer. She took a deep breath. "And now, Tinka my dear, I have to risk another mistake. And the penalty will be *your* life."

"Jane, what are you—"

"We need a volunteer and you're the only one qualified. There are no choices for any of us. I'm sorry. I didn't get the idea deliberately."

"Jane," said Tinka in bafflement, "what are you talking about?"

"You're a pilot," said Jane.

"Yes, but what's that got to do with it?"

"We can't use a raft, so we'll have to fly."

Oh, Mother, thought Tinka. *She is mad after all. Crazy as a crimson-crested coot.*

"Jane," she said gently, "there are no daSilva octahedra on Qish. No dynawings. Not even a backpack minicopter."

"I was thinking of something more primitive."

They found a good launch site halfway up the volcano, where the trees opened out into a long clearing.

"I hope this works," said Sam.

"So do I," said Tinka, who was going to fly it.

They had stretched cloth across a frame made from bamboo-like plants, in a kite shape. A crude hang glider.

When Jane first explained her idea, Tinka objected. You can't fly a hang glider fifty miles across open sea. The thermals are all wrong. But Jane had thought of that too, and the curious U-shaped device attached to the tail was the result.

On Qish it is never hard to find syntei. By rooting around in the bushes, Sam had found a dozen, of various sizes, in less than half an hour.

They strapped Tinka in, along with one of the syntei. When she reached land, they could join her through its counterpart.

"Muumaani preserve me," Tinka muttered, took a deep breath, and pushed off down the slope. The wing dipped once, alarmingly, and then it caught the sea breeze. Tinka gasped as the trees rushed up the slope towards her, growing with frightening speed. She pulled various ropes and the glider started to climb, missing the treetops by all of two feet. Then she banked it towards the west, where mountaintops beckoned. But already the glider was starting to lose height. Tinka muttered invocations under her breath to everything from the legendary Deceitful Maidens to the Laws of Aerodynamics—with more faith

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in the former. The monster-laden ocean loomed too close below.

Sam spoke through an inch-diameter falasynte to Jane, waiting at the edge of the crater lake. She was holding a synte weighted with rocks.

"Now!"

She lowered it carefully into the water. To Tinka it felt as if someone had switched on a booster rocket—which in a way they had. The glider doubled its speed and began to gain height.

She looked back and saw a reassuring jet of water spurting behind her. In the tail assembly was a synte, connected to one in the lake. The water, instantly losing several hundred feet in height, shot from it at high speed. There was no propulsive reaction at the synte mouth, so the flow had to be funnelled around a U-bend, producing enough pressure to give the glider a good hard push. A lakeful of water may not be inexhaustible, but it does make fuel consumption figures academic.

Tinka shouted a wordless cry of joy, confident now as the wind brushed her face. The first water-powered hang glider in the history of the universe headed towards the distant coastline. ■

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By Tom Easton

Seventh Son, Orson Scott Card, TOR, $17.95, 241 pp.
Wyrms, Orson Scott Card, Arbor House, $16.95, 224 pp.
Prisoners of Arionn, Brian Herbert, Arbor House, $17.95, 416 pp.
Mindplayers, Pat Cadigan, Bantam, $3.50, 288 pp.
Dawn, Octavia Butler, Warner, $15.95, 264 pp.
Code Blue: Emergency! James White, Ballantine/Del Rey, $2.95, 288 pp.
The Patch on the Odin Soldier, Geoffrey Marsh, Doubleday, $12.95, 182 pp.
Chance and Other Gestures of the Hand of Fate, Nancy Springer, Baen Books, $3.50, 256 pp.
The Year's Best Science Fiction, Gardner Dozois, ed., St. Martin's, $11.95, 600 + xxi pp.

Orson Scott Card is a writer of rare subtlety, enormous skill, great productivity, and—I hear—considerable personal charm. He is an ornament to the SF field, having picked up a 1986 Nebula for *Speaker for the Dead* (his second, after *Ender's Game* the year before), and it is something of a marvel that he arouses raging envy in as few breasts as he does.

My praise is stimulated by his latest book: **Seventh Son,** the first volume in a trilogy that might have been inspired by the late Manly Wade Wellman. The setting is an alternate frontier America, where history differs (George Washington is dead, Daniel Boone shot Aaron Burr in a duel, only seven colonies joined the American Compact, the Indians or Reds are enjoying an Industrial Revolution of their own), and the homespun magics of Appalachia work. The people wield hexes and hex signs, beseechings and compellings, and many have knacks that make work simpler and easier. And now is born Alvin, the seventh son of a seventh son, for whose desires the very world itself seems to

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fall into shape, against whom every drop of water is in league, along with mysterious other forces. Yet there are also potent protective forces arrayed in his favor. He has a loving family. There is Talespinner, the boy's mentor for a while. There is little Peggy, daughter of a taverner, a "torch" who sees each person's deepest nature. There is the one-eyed Red, mysterious visitant, beneficiary of Alvin's ability to make things right, and apparent title character of volume two in the series, *Red Prophet*.

Alvin is an innocent. His knacks are a constant marvel to him. He is a stranger to pride, and to paranoia. To those around him, it is plain that water and the local preacher are his foes (though no one knows why). He is, suggests Card, a Maker, a Christ figure, and his future role must be to save the world, or at least some significant part of it, from that evil force known to Alvin and Talespinner simply as the Unmaker.

The point of *Seventh Son* is merely to introduce Alvin to the world and to make plain his perils and his promise. It is enough to make me look forward eagerly to the next, and to forecast with confidence that the trilogy will before long be available in a single omnibus volume, that it will gain hordes of delighted readers, and that it will garner for Card yet another prize or two.

With Alvin, Card explicitly identifies good with creation, saying the world's Makers are its heroes and gods. Evil is whatever undoes a Maker's efforts. At the same time, he offers a subtheme, that an important ally to evil is the sort of selfishness that puts one's own interests ahead of those of others, or of society.

With **Wyrms,** his second novel for the summer of 1987, he reverses the priorities. Here the hero is Patience, daughter of Lord Peace, true Heptarch of Imakulata, a world settled seven millenia ago by Greek Orthodox colonists. Yet Lord Peace is not Heptarch; he serves a usurper as a slave-diplomat, and his daughter is in training to succeed him.

Why does Lord Peace not flee? Or overthrow the usurper? The true Heptarch, he says, must serve the King's House, and the King's House is all the world. The realm must come before self and family.

Patience learns that she is the seventh seventh seventh daughter of the original Starship Captain who brought humanity to Imakulata, prophesied to bring the Kristos and either save or destroy her people. Peace dies. The Heptarch shows his fear of the prophecy by trying to kill Patience. She flees, drawn by the call of Unwyrm to Cranning, the mountain wherein all Imakulata's Wise—scientists, philosophers, thinkers—have disappeared.

Patience learns of Imakulata's strange biology, and of the wyrms, natives of Imakulata, their death, the birth of Unwyrm in the same litter that created Imakulata's other sapients. She meets those other sapients, the telepathic geblings, the will-less gaunts, the memoryless dwelfs. She learns just how inclusive the King's House must be if Imakulata is to know peace and thrive. And she learns why Unwyrm calls her: he too knows the prophecy, and he intends her to bear his children, perfect blends of native and human, more fertile, more intelligent, more vigorous, destructive of all she holds dear.

Somehow, she must defeat Unwyrm. Selflessness must conquer selfishness, and then, perhaps, Imakulata's Makers can flourish.

The idioms of *Seventh Son* and *Wyrms* are very different, the former Wellman-

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ian, the latter more ornately Wolfeian, but their concerns are the same and they reinforce each other. I suggest you buy both, and read them back to back, as I did. If you do not, those differences in idiom may keep you from getting all the richness of meaning that Card intended (consciously or unconsciously).

Because I hadn't thought much of Brian Herbert's *Sudanna, Sudanna,* I looked upon his latest effort, when it bounced onto my desk, with a jaundiced eye. Here was someone who said he wrote SF, who let his publisher announce to the world that he wrote SF, who tossed into his tales a plethora of planets and stars and spaceships and other gizmos, but who displayed a colossal indifference to the principle of plausibility that rules SF. He was a fantasist who used the trappings of science and science fiction to con the reader.

I gave him another chance anyway. And I am happy to report that though I didn't much like **Prisoners of Arionn,** it is much better than *Sudanna*. Herbert remains a fantasist indifferent to plausibility, but his pseudo-SF fantasy is only backdrop to the tale of a family that is weird indeed. His affinities, despite his parentage, may lie more where the mainstream and the flow of science fiction join in that current we call the absurd.

Herbert begins his tale as a strange fog engulfs San Francisco. The fog, we soon learn, is produced by a gang of scampish students from the distant world of Arionn. They have carved the Bay area free of Earth, enclosed it in a bubble, and launched it toward home, a space-going habitat for eleven million human beings. Presumably, it will become something like a zoo.

But the habitat carries within it a zoo much more worth observing, and it is here that Herbert focuses his attention. He gives us the Fouquet family:

*The mother, Rachel, a lunatic only partially under control (when she remembers to take her pills); she neglects the house and starves the children, spending the food money on booze.

*The father, Henry, slave to his family's needs and his own rebellion against his patrician mother's expectations; he speaks in tongues.

*The children, starring Michelle, a sensible eleven year old who does the best she can.

*Beauregard, emissary of the spirit realm; he takes the form of a giant flea clothed in the uniform of a Civil War general.

*Granmere Liliane, Henry's mother and City Councilwoman; she becomes Acting Mayor when the real Mayor is overcome by a case of the hiccups.

Do you get the idea? The Arionnese crisis is but the frame for a bughouse, and if it actually enters the story from time to time, so would said frame, when the bugs batted themselves against their walls.

Is there a plot? Well, yes, though its logic owes much to the logic of dreams. A mad general comes to Acting Mayor Liliane with a mad scheme for defeating the Arionnese. Granpere gives Michelle a magical box. Rachel descends further into madness, Henry despairs and decamps, and Rachel rediscovers certain mad competencies. The general's scheme builds, and fails. And the book ends somewhat before the habitat reaches Arionn.

The publisher's poop sheet says that Herbert's "previous novels have been satirical in tone, but now [he] turns his talents to serious science fiction and has written one of the most acute and moving novels of the year." There are two errors here. The first is that Herbert re-

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mains as satirical as ever, but he has much more control over his material; he is, perhaps, moving toward becoming the successor to R. A. Lafferty. The second is that though he is indeed moving, he is hardly acute; the brush with which he paints character—and satire—is too broad for that claim.

Pat Cadigan's first novel, **Mindplayers,** is in some ways a disappointment. The idea is nifty: She gives us a future America close kin to that of the cyberpunks. Here too, the human brain is a computer, with all knowledge, personality, and humanity merely software. Heroine Alexandra "Allie" Victoria Haas lives in a world where people can swallow neuroses—paranoias, fetishisms, phobias—and even psychoses like pills, where dream feeders stimulate dreams and thrillseekers delve into your mind to learn what *really* turns you on, where pathosfinders find and activate the creative on-buttons of artists, where personalities can be franchised and the about-to-be-famous can have their minds stolen, or brainsucked. Where, in other words, mindplaying is a way of life, and death.

Since the mind is now a product, one must have a license to alter one's consciousness. And there are now two new classes of criminal: those who peddle and those who consume illegal neuroses, psychoses, and other mindwarpers. Allie is the latter, an unlicensed consumer. Her friend, Jerry Wirerammer, is the former. And one day he brings Allie a madness that doesn't go away when it is supposed to. She has to be dry-cleaned, and then the Mind Police have her.

Fortunately, the authorities recognize that Allie has talent, and Cadigan leads us after her heroine into the study of mindplay, first as a trainee pathosfinder and then as a professional. She shows us Allie on the job, and Allie obsessed with the ghost of a regenerated brainsuck victim within her head, persisting despite the original's death, and Allie plagued by a Wirerammer who, though still alive, is dispersing into the air of the mindplay world. She tells us that, yes, here is a strange new world, and yes, it will be the death of some of us, but look! some it will enable and liberate, just as have all past new technologies. Excellent stuff, perceptive, imaginative, subtle, and penetrating. A pleasure to read, and a writer to admire.

How is the book a disappointment? The seams show. The transitions from episode to episode are too abrupt. One segment appeared in *Asimov's* in 1983, and then in the first Dozois *Best of the Year*. As well, the author's acknowledgements page thanks a number of editors (and other people) for help and encouragement. So you may well have read much of this one before. If so, you will feel cheated, for nowhere does the book admit that it has ever been published before, in whole or in part. Be warned.

It is always a pleasure when another Octavia Butler novel arrives on my desk. This time, the novel, is **Dawn,** and the pleasure is magnified, for it is the opening shot in her new *Xenogenesis* series. I—and you—have several more stimulating, rewarding, and delightful evenings in store.

Dawn's premise is that not long from now, the balloon will go up. The missiles will fly, civilization will die, and a handful of survivors will wander, dazed, among the ruins. It's a familiar scene, but in Butler's tale it is only a hazy memory. She begins when her heroine, Lilith Iyapo, awakens in a strangely featureless room. She remembers awak-

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ening before, and being interrogated by disembodied voices. Now she learns that she has slept for 250 years aboard an alien spaceship while aliens studied her and other humans and helped a battered Earth recover. Why do the aliens bother? They are gene traders, driven by a deep biological need to add to themselves the genes of other sapient species, and to give their own genes to them.

Unfortunately, the aliens are covered with snaky tendrils that serve as eyes, ears, and other senses. They are repulsive to human sensibilities. And it is Lilith's first task to conquer her own xenophobia. Then she will awaken more of the surviving humans and help them adjust to the new reality.

In SF we are used to the idea that alien contact must mean a hybridization of cultures, just as it has on Earth. Butler says that cultural contact is all well and good, but it is irrelevant beside the deeper, more intimate, more far-reaching and threatening and promising contact that leads to the hybridization of species. She has a problem in that we have no language except that of metaphor for what such contact might mean, but she makes do admirably by giving the alien Oankali three sexes, one of which, the ooloi, senses and manipulates DNA directly and serves as intermediary between male and female.

The first step in the hybridization of species is to bond humans to ooloi, perhaps, one finally realizes, to give humans a third sex too. And here we may have Butler's real pont: The ooloi are the means for gene transfer between species, but they also come between, they are intermediaries, moderators, buffers, and Butler says that the human tragedy is the unfortunate combination of intelligence and hierarchy. She then shows that tragedy in action, stressing the conflicts of male and female, emphasizing the particular variety of fat testosterone fosters in the male head but recognizing that women can also be "difficult." We need, she says, something very like the ooloi if we are ever to outgrow the battle of the sexes, and then—if we are very lucky—the larger battles of races, religions, nations, and ideologies.

When *Dawn* ends, the first humans are about to be returned to the Earth they had despoiled. A few have begun to sense the waiting depths of the partnership with the Oankali. Most have not.

I expect those waiting depths will fuel a great deal of plot conflict for the next book or two in the series. Eventually, a new species will arise, neither human nor Oankali, but something else, perhaps something better than either. Then we may recognize that Butler has gifted SF with a vision of possibility more original than anything we have seen since Clarke's *Childhood's End*.

We might already recognize *Dawn* as a classic, new as it is, if it did not contain gaps that disrupt our sense of character and event. These gaps may be deliberate, but they do make me think of editors who insist that a writer trim a manuscript to size to suit a preconception of the market with little or no consideration for the size of the story.

The last time I reviewed one of James White's Sector General novels, I predicted that he would, for his next, find a certain solution to the problem of the Gogleskans, who, because of their evolutionary history, respond to a certain distress call by trashing everything in sight. Apparently, White had not at that point thought of the idea himself. But he did like it. And when he wrote **Code Blue: Emergency!** he therefore put into

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it: "Like everyone else in Maintenance, she knew about those [sound] distorters. Suggested and designed by Ees-Tawn, the department's head of Unique Technology . . ."

I put it to you: When a kibitzer finds himself in a kibitzee's book, he feels *very* gratified. There is no greater compliment. Thank you, James White.

And now, just to prove that he hasn't turned my head with his flattery, I should tear *Code Blue* to shreds. I suppose I could. White is weak on many of the so-called "literary" values, such as characterization; his aliens generally feel very human; his plots are straightforward and uncomplicated. But he has always been weak in this way, and attacking him for it would not be fair. It would ignore everything I—and you—have always loved about the Sector General stories. They reside in an almost unique realm where the problems are those of nature and the conflicts that drive the plots are nonmilitary. White's imagination is devoted to finding new anatomies, physiologies, psychologies, and even systems of honor that put new demands on Sector General's healers and demonstrate the coping power of intelligence. It's SF in the classic mold, to which it adds a moral lesson on the value of tolerance of such intensity that it must send old-line racists and sexists shrieking into the night.

And it's all there in *Code Blue*. Cha Thrat is a healer on the newly discovered world of Sommaradva when a flyer crashes. The sole survivor of the crash is a human from Sector General, but he is badly injured. Cha Thrat overcomes her reservations about the fitness of intervening in ignorance, patches him up, and saves his life. She then accepts an invitation to go to Sector General, the interstellar hospital, as a trainee.

Unfortunately, Cha Thrat is an outspoken individual used to the status of a fully trained surgeon. She does not know her place, and she becomes as irrepressible a kibitzer as I am. In addition, she has an annoying tendency to be right. Predictably, she angers her nominal superiors, gets transferred, gets demoted, gets dumped in Maintenance, and finally returns to the medical limelight via the Gogleskan problem, with an assist from some friendly puppetmasters with a problem or two of their own. And the lesson—tolerance—is as strongly present as ever.

If you like classic SF, or medical SF, or James White, don't miss this one.

Geoffrey Marsh has a hero of vast potential in Lincoln Blackthorne, the New Jersey tailor who gets involved in various fantastic adventures and constantly alludes to a very busy past. Soon after picking up a Marsh novel, one gets the feeling that it is but the latest in a long, long series. But the truth is simpler: to date, there have been only three. The first, *The Tail of the Arabian Knight*, I enjoyed and reviewed. The second, *The King of Satan's Eyes*, I did not read. The third, **The Patch of the Odin Soldier,** is the one at hand.

That is, I read it. I did not enjoy it. Marsh starts Blackthorne off in a Maine woods colored far more by ignorance—migratory moose, forsooth!—than by experience (even via a guidebook, the omnipresent research tool of the adventure novelist). He brings on stage two old acquaintances with the proposal that Blackthorne help them lay hands on a small statuette whose left eye, hidden by a patch, has powers that can let its possessor remake and rule the world. He then has Blackthorne narrowly escape bombs, rampaging milk trucks, arrows, bullets, poison gas, molten

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lava, and so on, until he finally manages to save the world.

It seems likely that Marsh is satirizing that old school of writing whose basic rule of plotting was, whenever the writer's imagination flagged, to have another villain come through the door with a gun. Unfortunately, this book is not leavened by the charm of the first, for here Blackthorne is a tailor in name only. And the satire is too crude to stand alone.

Nancy Springer's fantasy collection, **Chance and Other Gestures of the Hand of Fate,** contains some marvelous work, but it is uneven. At her best, Springer has a sure touch and an enchanting way of looking sideways at the conventions of a genre that is riddled with the things. The title story, "Chance," is remarkable for its raunchy view of woodland sprites. "The Boy Who Plaited Manes," magically poignant, is almost enough, by itself, to justify the price of the book. "Primal Cry," while neither SF nor fantasy, is a near-perfect evocation of the hidden nastiness of small-town America.

The unevenness I mentioned? "Chance" 's sequel, "The Golden Face of Fate," quickly degenerates into Tolkienesque Ents. "The Prince out of the Past" is a charmer, but it derives too plainly from Moorcock's Eternal Champion. And several stories strike me as eminently forgettable.

Buy it for the goodies, and because you know forgettability is a matter of taste.

Gardner Dozois' fourth annual anthology of **The Year's Best Science Fiction,** necessarily from a new publisher now that Bluejay has folded its tents, is here. And, as before, it is an excellent compendium of the best and the latest. Here you will find the first few chapters of Card's *Seventh Son,* as "Hatrack River." There are Somtow Sucharitkul's "Fiddling for Waterbuffaloes" and Harry Turtledove's "And So to Bed," both from this magazine. There are tales by Lucius Shepard, Damon Knight, Pat Cadigan, Robert Silverberg, Tanith Lee, Michael Swanwick, John Kessel, Greg Bear, Bruce Sterling, Jack Dann, Howard Waldrop, Tim Powers, Kim Stanley Robinson, and more, for a total of 27 stories. And every one of them is excellent. The book is a marvelous buy.

When Gardner became the editor of *Analog*'s companion magazine, he began to apologize in his anthology. He was, he implied, quite naturally biased, but, durnit, the stories in *Isaac Asimov's Science Fiction Magazine* were good stories and he wasn't about to not pick them just because he had picked them once already.

That seemed reasonable enough to me. I counted the *Asimov's* stories in his second anthology, prepared before he became the magazine's editor, and found eight of 26. I counted those in his third, prepared after he took the editorial seat but before any of the stories he had bought for the magazine had appeared in print and became eligible for the book: eight of 24. Gardner did not seem to be letting his natural biases stack the deck too badly at all. The proportion was up only a hair, and not enough to be significant.

In Number Four, however, there are 11 from Gardner's magazine, out of 27, and that *is* up. The increase is understandable, yes, for these stories are all from the year when Gardner's picks for the magazine first became eligible for the anthology. He thought they were good once. He thought they were good again. *They are good,* and in fact Dozois

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has the Nebula-wining novella (Shepard's "R&R") and short story (Bear's "Tangents") here, with the winning novelette (Wilhelm's "The Girl Who Fell into the Sky") in his list of honorable mentions. But there are so many stories from one source that the book strikes the reader as having less variety than it should. I respectfully suggest that Gardner should do two books, one *Best of Asimov's* and one *Best of the Year*, including only the one or two best from the first book.

It used to be that we could get at least a partial reading on any Bestologist's biases by comparing his "Best" with another. Last year, there were three of these "Bests": Gardner's, Don Wollheim's, and Terry Carr's. I don't yet know how many there will be this year, but if we see one from Carr, it will be the last. He died recently, and he will be sorely missed, both for his "Bests" and for his original anthology, *Universe*, which for many years has provided more than its share of excellence for our field's "Bests."

I have not heard of any solid plans for a replacement for the Carr "Best." Happily, it's a different story for original anthologies. Just in time to fill the niche left vacant by Carr's death, George Zebrowski has announced the four-volume (so far) *Synergy* series (Harcourt Brace Jovanovitch) and Lou Aronica and Shawna McCarthy have announced the annual *Full Spectrum* (Bantam). ■

IN TIMES TO COME

Usually the best help is the help you give yourself—but sometimes the dice are so loaded that even those who realize that must seek outside aid. Such a case occurs in next month's cover story, "Strangers," set on one of those vivid, intricately crafted alien worlds that Poul Anderson creates (and David Hardy illustrates) so well. It has (at least) two groups of intelligent natives, both evolving toward civilization, but along such different paths that one of them has a disproportionate edge when changing conditions on their homeworld throw them into direct competition. And then there are visitors, mysterious and seldom seen, but possessing powers that suggest they might help even the balance. They are wise enough to be reluctant, but there is one thing they can do. But even that is not without a price, for everyone concerned . . .

It's unusual for us to have two "State of the Art" pieces in a row, but it looks like it's going to happen. This time it's "The Last Cavalier," John F. Carr's look back at the life and tragic death of one-time *ASF* regular H. Beam Piper. We'll also have "Cosmology Without the Big Bang," a regular science fact article by Paul S. Wesson, one of the developers of the new breed of cosmologies described by the title. And, of course, various and sundry stories by such folk as Rick Shelley and Geoffrey A. Landis—and Part III of Lois McMaster Bujold's *Falling Free*.

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brass tacks

Dear Stan:

I greatly enjoyed the fanciful "A Hole in the Sun," by Roger MacBride Allen in the April '87 *Analog*. Wow! It would make a beautiful video movie.

Unfortunately, Allen has the solar differential-rotation-rate with latitude all backwards. The solar equatorial rotation is 26 days and almost 37 days at the poles. Observed at the moving Earth, solar rotation is 27 days at the equator to nearly 41 days at the poles.

It is this differential rotation that drags the solar magnetic field around and around the solar equator like bundles of twisted spaghetti, leading to warping and twisting and magnetic shearing. This produces sunspots with solar active regions, where bundles of magnetic field lines bulge out from the solar surface. This is likely the result of a much higher solar interior rotation rate producing a higher physical centrifugal sheer stress at the solar equator.

Anyone who wants a Public Domain computer graphics BASIC or FORTRAN program for time translation of sun-spots, with differential rotation and null-point compensation for solar spherical coordinates conversion to Earth-view type rectalinear, should send $1.00 and a double-stamped addressed business envelope.

KERMIT L. SMITH
7505 Mandan Rd. # T-2
Greenbelt, MD. 20770

REF: The Quiet Sun by Edward G. Gibson
Lib. of Congress Cat. # 72-600092
NASA SP-303, $6.20 postpaid.
Stock No. 3300-0454
U.S. Government Printing Office
Washington, D.C. 20402

Dear Mr. Schmidt:

I was disappointed by Richard D. Meisner's article (*Analog*, April 1987).

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Mr. Meisner's presentation of opposing theories was marred by the omission of crucial facts. Further, if one accepted Mr. Meisner's line of reasoning, the first casualty would be his own conclusion!

Modern quantum field theory is dominated by the concept of spontaneously broken local symmetries, while modern cosmology is dominated by the concept of inflation; these trends are related, and are based upon a good deal more than mere style. If these theories are valid, then the entire observable universe is but one of many "bubbles" in which the Higgs fields have "crystallized" into a particular configuration. Due to subsequent inflation, our "bubble" has expanded faster than our particle horizon: the isotropy of the observable universe is an artifact of this expansion.

The key facts here are that the "laws of nature" and "fundamental constants" we know are artifacts of the way the Higgs fields have "frozen": in a different "bubble," you might have not only different "fundamental constants" but entirely different "laws." The question is not whether carbon could form in some particular "bubble," but rather whether the "fundamental particles" resemble anything we know.

Mr. Meisner spends a good deal of time discussing the relative strengths of strong, electromagnetic and weak forces, but it is not clear whether any of these would exist. If some other "bubble" has a different constellation of fermions ("matter") and bosons ("forces"), we have no known basis for predicting whether life is possible, unless we cheat and define life as carbon-based.

Mr. Meisner's exposition of the Many-Worlds interpretation is specious. If the particles we know are the remnants of a Yang-Mills field whose symmetry is broken by the Higgs mechanism, then there are several ways for the symmetry to break. Presumably, the "Great Hamiltonian in the sky" would have Eigenstates corresponding to the various decompositions of the symmetry group. Not only would there be different values for the "fundamental constants," but there would be an entirely different set of "fundamental constants."

The most serious objection to Mr. Meisner's argument is that he does not address the physics governing the Creator. If the Creator is a carbon-based lifeform, or even inhabits a world allowing such lifeforms to evolve, then nothing has been explained by postulating His existence. But if He is not a carbon-based life form, His existence demolishes the central argument: carbon is not necessary for life. It may be possible to prove that the observable universe is an artifact, but not with a self-contradictory line of reasoning!

Mr. Meisner's offhand reference to *The Anthropic Cosmological Principle* was unexpected, given the tone of the article. In their book, Drs. Barrow and Tipler carefully distinguish among several distinct "anthropic principles." They clearly label everything but the Weak Anthropic Principle (WAP) as speculative.

My reference to cosmology and quantum theory are, of necessity, horribly oversimplified. The size limitations of "Brass Tacks" make it inappropriate to explain such concepts as $E8 \times E8$, $SO(10)$ and quotient groups. The interested reader should consult any recent texts on cosmology and on quantum field theory, or any of the recent symposia for which he has the background. One good source of both papers and references is *Inner Space/Outer Space: The Interface Between Cosmology and Particle Physics*, University of Chicago Press, 1986. Also, there are a lot of

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popularizations on the market for both cosmology and quantum theory.

In at least one prior issue you published two articles advocating opposite sides of a scientific question; I think it was the question of "are we alone?" I believe that such a policy is wise in general, and certainly would have been appropriate in this case.

SEYMOUR J. METZ

Annandale, VA

The author replies . . .

The question of whether there could be entirely different kinds of fundamental forces is an interesting one, and leads to the question: beginning with nothing, what exactly is required for the creation of a complex universe? We would certainly need something like a nuclear binding force, to hold things together. In addition, if we want at least two distinct scales (microscopic/macroscopic), a longer-range attractive force will be needed as well—perhaps something like gravity. And, of course, we will have to include a force capable of allowing some degree of attraction/repulsion (and hence, of structural elaborateness)—if not the electromagnetic force, at least something like it.

Since the array of fundamental forces needed for complex structures must always bear at least this degree of similarity to those we're familiar with, I suspect the issue of exact relative strengths of these new forces would be about as important as we find it to be in this universe.

(A correction to Metz: bosons are not "forces," but integral-spin particles [such as photons and mesons] whose numbers are not conserved in particle interactions).

I suggest Mr. Metz consult the Barrow & Tipler reference (p. 499-501) for a clear discussion of the initial splitting of the universe per the Many-World interpretation. The branching can only occur once the universe has a non-zero radius, and the universal wave function is scaled by the Planck length. Both these considerations make it clear that the fundamental constants defining the Planck length must exist before the universe can start splitting, and that all the "parallel universes" would thus have the same set of fundamental constants.

I didn't specify a governing physics for the theoretical Universe Maker, and certainly don't believe that he/she/it must be carbon-based. As I said in the article, in order for the artifact hypothesis to be tenable we would require that consciousness be able to exist and operate independently of the structures of any type of physical "universe" (a possibility which has, incidentally, gained the support of many quantum physicists. John Wheeler has suggested that our own *consciousness has brought the universe into existence, through a backwards causality mechanism).*

To sum up—I was not writing on the remarkability of the existence of consciousness (which may in fact be eternally existent, if truly independent of spacetime/matter/energy), but on the remarkable contingency involved in the existence of physically complex structures, such as biological life, in this universe.

True, Barrow & Tipler discuss several types of "anthropic principle." I don't see how it applies as a criticism; perhaps it wasn't intended as such.

RICHARD D. MEISNER

Dear Stan:

I greatly enjoyed Richard Meisner's article, "Universe—The Ultimate Artifact?" in the April issue. However, Meisner seems to make a very common philosophical mistake when he poses his

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basic question: "The fundamental mystery is not how the constants came to have their observed values, but why those constants turn out to be precisely those required for a life-compatible universe."

There is no more mystery to this than there is to the fact that oxygen-breathing creatures have populated a planet whose atmosphere is rich in oxygen. The universe has evolved the way it has evolved; life arose in the conditions that existed. If the universe had evolved differently, if the basic physical constants had been such that life could not have arisen, then life would not have started, there would be no living creatures to ask why we happen to be here—because we wouldn't be!

I must confess, though, that the idea of the universe as the deliberate construct of some intelligence does have a certain fascinating appeal. I explored this idea in my novel *Orion*, and have further developed the theme in its sequel, which will be published early in 1988.

In the *Orion* novels I deal with one aspect of this concept: Granted that time travel is possible, then it becomes feasible to consider that our very advanced ancestors went back in time to create the universe in which we now live. They would, of course, arrange all the physical constants of "their" universe to be just right for life to arise.

In other words, we have met the gods, and they are us!

BEN BOVA

Dear Stan:

I found Richard Meisner's high-tech update of the "Argument from Design" (*Analog*, April 1987) no more convincing then its classical forebears. In opposition to J.B.S. Haldane, Meisner apparently believes that not only is the universe no queerer than we can suppose, but that we have already supposed all the possible queerness it has to offer. How else to explain his conviction that the only possible kind of life is our own kind: carbon-based, planet-born, and sunlight-powered?

What Meisner has shown, and fairly convincingly, is that small changes in the rules governing the universe result in universes quite different from our own. What he has not shown is that life of any sort is impossible in all these other universes. In presenting his argument, Meisner ignores speculations on the possibility of crystalline life, nuclear life, plasma life, superfluid life, etc. —speculations certainly no more outrageous than his own conception of the universe as a made thing. Indeed, one exciting recent development in evolutionary theory is the possibility that life on Earth originated as self-replicating patterns of crystal defects in clay, which only later became infected with organic matter.

Meisner's presentation is also maddeningly incomplete in some ways. He tells us, for instance, that under certain sets of laws supernovas could not explode. Well, what *would* they do, then? Meisner doesn't say. Then again, under certain other conditions, atoms themselves could not exist. Fine, but surely *something* exists in their place. What this something might be, however, we are left to guess. And in each such case Meisner simply assumes that the unspecified alternative precludes life.

Even granting for the moment Meisner's insistence on more-or-less conventional chemistry, his corollary requirements for stars and supernovas to create and disperse the various elements seem unnecessarily restrictive. Surely there's a range of conditions under which the Big Bang itself could seed

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space with a wealth of elemental variety. And even if stars could not exist as stable energy sources, why not massive brown dwarfs, radiating away the thermal energy of gravitational collapse over the course of billions of years. This happens even in our universe, as Jupiter demonstrates. Yet Meisner makes no mention of these possibilities.

Finally, his invocation of parapsychology as a potential "explanation" of his hypothetical creating intelligence is laughable. ESP, in the unlikely event that it exists at all, must be either natural or supernatural in mechanism. If natural, it can have very little to do with Meisner's supernatural creator. If supernatural, then surely no science can hope to explain it.

And so we come to the fatal flaw in Meisner's whole argument: his attempt to use physics to answer a metaphysical question. He reveals his metaphysical bias when he says that "If the constants are explainable by unknown laws of physics . . . we are still left to wonder why the laws happen to lead to a universe compatible with life." In other words, no purely physical explanation will satisfy. Meisner's central question comes down to the repeated and unanswerable "Why, Daddy?" of every small child. Faced with such an infinite regress, "I am that I am" becomes perhaps the only sensible reply.

This, I believe, is the real motivating core of religious conviction. For thinkers such as Newton and Einstein, faith came before purely physical phenomena such as the size of the moon's disk or the exact values of the fine structure constants. To imply as Meisner does that mere catalog of cosmic coincidences alone could inspire such faith is, I think, a great disservice to the memory of these great scientists.

GREGORY KUSNICK ■

●There are 640 million earth-type planets in your own galaxy; planets so much like ours that you could step out of a space vehicle, take a deep breath of oxygenated air and look up at a blue sky. Many astronomers and other scientists interested in the whole question believe that the universe is crawling with life.

Is it not possible that much of it, since the numbers are so staggering, is equal to us in intelligence, or superior, simply because human intelligence has existed for so relatively short a period?

Stanley Kubrick

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a calendar of analog upcoming events

13-15 November
PHILCON '87 NEW INFORMATION (51st Annual Philadelphia SF conference) at Adam's Mark Hotel, Philadelphia, Penna. Guest of Honor—Robert Silverberg, Artist Guest of Honor—Tim Hildebrandt, Special Guest of Honor—Timothy Zahn. Registration—$15 until 1 November, $20 at the door. Info: Philcon, Box 8303, Philadelphia PA 19101.

27-29 November
LOSCON XIV (Los Angeles area SF conference) at Hilton Hotel, Pasadena, Calif. Guest of Honor—C.J. Cherryh, Fan Guest of Honor—Tom Whitmore. Registration—$15 until July 1987. Info: LASFS, 11513 Burbank Blvd, North Hollywood CA 91061. (818) 760-9234.

4-6 December
TROPICON VI (south Florida SF conference) at Holiday Inn Oceanside, Ft. Lauderdale, Fla. Guest of Honor—George R.R. Martin, Artist Guest of Honor—Gail Bennett. Registration—$12 until 31 October, $15 thereafter. Buffet banquet—$19. Info: SFSFS Secretary, Box 70143, Ft. Lauderdale FL 33307.

24-25 December
POLECON MCMLXXXVII (High Arctic SF conference) at the Workshop. Guest of Honor—K. Kringle, Artist Guest of Honor—J. Frost. Fan Guest of Honor—Rudolph. Due to previous years' problems registration is limited to good boys and girls. Seasons Greetings from your Calendar of Events compiler.

15-17 January
RUSTYCON V (Pacific Northwest fan-riented SF conference) at Everett Pacific Hotel, Everett, Wash. Guest of Honor—Philip Jose Farmer, Artist Guest of Honor—Steven A. Gallacci, Fan Guest of Honor—Betty Bigelow. Registration—$18 until 31 December 1987, $22 at the door (registration limited to 800). Info: Rustycon V, Box 47132, Seattle WA 98146.

15-17 January
ESOTERICON V (Religion, Occult, SF, Magic conference) at Sheraton Meadowlands Hotel, East Rutherford, N.J. Info: Esotericon V, Box 22775, Newark NJ 07101

1-5 September 1988
NOLACON II (46th World Science Fiction Convention) at Sheraton Hotel & Towers, Marriott Hotel, Rivergate Convention Center, New Orleans, La. Guest of Honor—Donald A. Wollheim, Fan Guest of Honor—Roger Sims TM—Mike Resnick. Registration—Attending $60 until 31 December 1987, $70 to 10 July 1988. Supporting—$30. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition, the works. Join now and get to nominate and vote for the Hugo awards and the John W. Campbell Award for Best New Writer. Info: Nolacon II, 921 Canal Street #831, New Orleans LA 70112 (504) 525-6008.

—Anthony Lewis

Items for the Calendar should be sent to the Editorial Offices six months in advance of the event.

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